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(54) Single-lens reflex camera system.

(57) An autofocus system of a single-lens-reflex camera (1) system. The autofocusing operation is executed in cooperation with a camera body (1) and a lens unit (2) mounted to the camera body (1). The cooperation is determined by the camera body (1) depending upon the performance of the lens unit (2) mounted thereto. In case the lens unit is equipped with computer means (10, 11) and lens drive means (60, 65), the camera body (1) merely detects a defocus amount and sends it to the lens unit (2), and the focusing operation is then executed by the lens unit itself.

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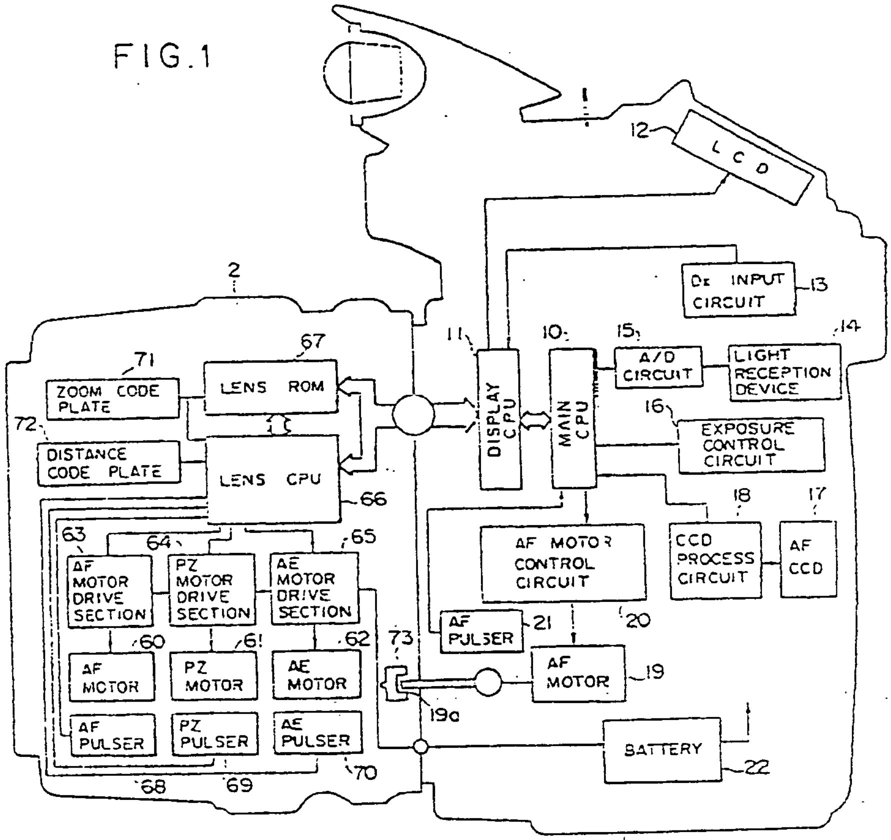
FIG.1


1
12
LCD
2
Dx INPUT CIRCUIT
13
11
10
15
14
67
71
ZOOM CODE PLATE
LENS ROM
A/D CIRCUIT
LIGHT RECEPTION DEVICE
72
DISTANCE CODE PLATE
LENS CPU
DISPLAY CPU
MAIN CPU
16
EXPOSURE CONTROL CIRCUIT
66
18
17
63
64
65
AF MOTOR DRIVE SECTION
PZ MOTOR DRIVE SECTION
AE MOTOR DRIVE SECTION
AF MOTOR CONTROL CIRCUIT
CCD PROCESS CIRCUIT
AF CCD
60
61
62
73
AF PULSER
21
20
AF MOTOR
PZ MOTOR
AE MOTOR
AF MOTOR
19
19a
AF PULSER
PZ PULSER
AE PULSER
BATTERY
22
68
69
70

Single-Lens Reflex Camera System

This invention relates to a single-lens reflex camera whose lens is interchangeable, and more particularly to a system which optimally performs an autofocus control operation depending on the performance in combination of a camera body and a photographic lens being mounted thereto.

To date, single-lens reflex cameras which are equipped with autofocus (AF) functions have been employed.

A single-lens reflex camera is a camera, to which a lens is interchangeably mounted. Since it requires a precise focusing adjustment, a method in which the amount of defocus is detected by the state of an image formed by light which passes through the lens, i.e., the so-called TTL (Through-The-Lens) type focus detection method, has been widely employed in AF (Automatic Focusing) operation.

When this method is used, a light reception device for AF operation is positioned in the body of the camera, and the elements to be driven are positioned in the lens unit. Thus, AF operation should be performed by connecting the lens unit and the camera body mechanically or electrically.

In the first case, i.e., mechanical connection, the lens unit is equipped with a drive force transmitting mechanism only, and an AF motor provided in the camera body is used to drive the lens unit. In the latter case, the lens unit is equipped with an AF motor which turns a motor on or off in the camera body so as to perform a focusing operation. However, in the systems described above, the non-linearity between the defocus amount and the amount of driving of the lens cannot be properly compensated for, because the conversion from the defocus amount into a number of pulses is conducted in a control circuit in the body. Thus, there was a problem since an optimum AF control corresponding to each interchangeable lens could not be performed.

In addition, in a structure where AF control and zoom lens driving are carried out with motors in a lens unit, since the items to be controlled in the lens unit increase, the computing capacity required for the body accordingly increases, resulting in the increase of the load to the camera body.

Where functions of the photographic lens units are increased, it is desired for individual photographic lens units to have data processing capacity therein.

It is therefore an object of the invention to provide an improved single-lens reflex camera system capable of performing more precise autofocus control with a lens unit having a control circuit therein for processing data, and to provide a camera body which distinguishes the data to be sent to the lens units depending on the typle of the lens unit attached to the body.

For the above purpose, according to the invention, there is provided a single-lens reflex camera system comprising a camera body and a lens unit which is interchangeably mounted to said camera body, said camera body including: detecting means for detecting a defocus amount based upon the condition of the subject image formed by light having passed through said lens unit; first transfer means for transferring data related to the defocus amount detected by said detector means, to said lens unit; and drive means for driving said lens unit, said lens unit including: memory means having stored information intrinsic to the lens unit; computer means for computing the driving amount of said lens unit corresponding to the defocus amount transferred by said first transfer means, with the information stored in said memory means; and second transfer means for transferring the driving amount computed by said computer means, to said camera body, wherein said drive means of said camera body being operated in accordance with said driving amount transferred by said second transfer means.

According to another aspect of the invention, there is provided a camera body of a single-lens reflex camera, to which a lens unit is interchangeably mounted, comprising: detector means for detecting a defocus amount based upon the condition of the subject image formed by light having passed through said lens unit, transfer means for transferring data related to the defocus amount detected by said detector means, to said lens unit; receiving means for receiving data related to a driving amount of said lens unit corresponding to said defocus amount; and drive means for driving said lens unit based upon said drive amount.

In a further aspect of the invention, there is provided a lens unit of a single-lens reflex camera to be interchangeably mounted to a camera body, comprising: memory means having stored information intrinsic to the lens unit; receiving means for receiving data from the camera body, said data relating to a defocus amount detected based upon the condition of the subject image formed by light having passed through said lens unit; computer means for computing a driving amount of said lens unit corresponding to said defocus amount with information stored in said memory means; and transfer means for transferring said driving amount to the camera body.

In still a further aspect of the invention, there is provided a single-lens relfex camera system comprising

a camera body and a lens unit which is interchangeably mounted to said camera body, said camera body including: detector means for detecting a defocus amount based upon the condition of the subject image formed by light having passed through said lens unit, computer means for computing a driving amount of said lens unit corresponding to the defocus amount detected by said detector means, with information stored in said lens unit; and transfer means for transferring the driving amount computed by said computer means, to said lens unit, said lens unit including memory means having stored information intrinsic to the lens unit; and drive means for driving the lens unit.

According to another aspect of the invention, there is provided a camera body of a single-lens reflex camera, to which a lens unit is interchangeably mounted which comprises: detector means for detecting a defocus amount based upon the condition of the subject image formed by light having passed through said lens unit, computer means for computing a driving amount of said lens unit corresponding to the defocus amount detected by said detector means; drive means for driving said lens unit, first determining means for determining whether said driving amount of photographic lens is to be computed by said computer means, and second determining means for determining whether said lens unit is to be driven by said drive means.

According to still another aspect of the invention, there is provided a lens unit of a single-lens reflex camera, to be mounted on a camera body, comprising: receiving means for receiving data from the camera body, said data relating to a defocus amount detected based upon the condition of the subject image formed by light having passed through said lens unit; memory means having stored information intrinsic to the lens unit; computer means for computing a driving amount of said lens unit corresponding to said defocus amount with information stored in said memory means; and driving means for driving said lens unit, in accordance with the driving amount computed by said computer means.

The invention will now be further described with reference to the drawings in which

Fig. 1 shows a block diagram representing one embodiment of the camera system relating to the present invention;

Fig. 2 shows a front view of the new camera body;

Fig. 3 shows a front view of the new lens mount;

Fig. 4 shows a circuit diagram of the new camera body;

Fig. 5 shows a circuit diagram of the new lens;

Fig. 6 shows a block diagram representing a combination of the new body and a conventional AEAF lens;

Fig. 7 shows a circuit diagram of a conventional AEAF lens;

Fig. 8 shows a front view of the lens mount shown in Fig. 7;

Fig. 9 shows a front view of the mount of a conventional AEAF body;

Fig. 10 shows a descriptive diagram of a conventional AE body;

Fig. 11 shows a descriptive diagram of a conventional AE lens;

Fig. 12, 13 and Fig. 15 to Fig. 17 show flow charts representing operations of the display CPU of the new body;

Fig. 14 shows a timing chart of the process of Fig. 13;

Fig. 18 to Fig. 20 show flow charts representing operations of the main CPU of the new body; and

Fig. 21 and Fig. 22 show flow charts representing operations of the lens CPU of the lens.

Referring to the accompanied drawings, embodiments are subsequently described, wherein the camera body embodying the invention is named "new body"; the lens unit with CPUs which can perform optical control operations along with the new body is named "new lens" so as to distinguish them from the bodies and lens units having been used in the conventional systems.

Fig. 1 is a block diagram which outlines the new system which is structured by a combination of the new lens and the body of the present invention.

The new body 1 is equipped with two CPUs; a main CPU 10 which processes various information for photographing and a display CPU 11 which is used to input information from switches and to exchange and display information for the new lens 2. Besides the main CPU 10 and display CPU 11, the new body 1 also includes a LCD panel 12 which displays various information, a Dx code input circuit 13 where an ISO film sensitivity is input with a Dx code which is printed on the film cartridge, a light receiver 14 which measures the brightness of a subject by an incident light beam through the lens, an A/D circuit 15 which converts analog signals of an output of the light receiver 14 into digital signals, an exposure control circuit 16 which controls a shutter in accordance with various photographic conditions being input thereto, an AF type CCD for detecting a focus condition which receives rays of a subject image formed by the light beam incident through the lens, and a CCD process circuit 18 which detects the focusing state of the photographic lens by an output of the AF CCD 17.

An auto focus (AF) motor 19, which serves to focus a lens, transfers a drive force to the photographic

lens through a coupler 19a (see Fig. 2) which is provided on the mount portion when a conventional type photographic lens which does not provide an AF motor therein is mounted. The main CPU 10 controls the amount of rotation of the AF motor 19 thorugh an AF motor control circuit 20 according to the signal of the CCD process circuit 18 and the pulse signal of the AF pulser 21 which detects the amount of rotation of the AF motor 19.

A battery 22 supplies electric power to each active element in the camera body described above, to a motor in a photographic lens described later, and to the CPUs.

On the other hand, the new lens 2 houses three motors which are an AF motor 60, a power zoom (PZ) motor 61, and an automatic diaphragm (stop) control (AE) motor 62. The three motors allow an auto focus operation, a power zoom operation, and a diaphragm control operation to be conducted with the drive forces in the camera body.

The new lens 2 provides a conventional gear mechanism or cam mechanism which performs the focusing and zooming operations by relatively moving each movable lens by rotating a focusing (cam) ring or a zooming cam ring. The AF motor 60 and the PZ motor 61 rotate the individual cam rings.

Each motor is controlled by a lens CPU 66 as a computing means (an arithmetic control means) through an AF motor drive section 63, a PZ motor drive section 64, and an AE motor drive section 65.

As an information input means to the lens CPU 66, there are a lens ROM 67 which is a storage means for storing information intrinsic to a lens; an AF pulser 68, a PZ pulser 69, and an AE pulser 70 which converts the amount of driving force of each motor into pulses and detects them; and a zoom code plate 71 and a distance code plate 72 which detect a rotational position of the zooming cam ring and the focusing cam ring.

The code plate actually is fixed to a cam ring, and a plurality of brushes slides on the code plate. The code plate detects an absolute rotational position of each cam ring by the contact state of the brushes. The "code plate" includes such a code plate and a brush in this specification. Fig. 1 shows the code plate as a general term.

The lens CPU 66 is connected to the control sections and the input means described above. The lens CPU 66 can communicate with the new body 1 through a set of electric contacts described later. For example, the lens CPU 66 has the function to receive the amount of defocusing detected by the camera body, references data stored in the ROM 67, computes the amount of drive force, detects the amount of drive force by the AF pulser 68, and drives the AF motor 60; or the function to detect the amount of drive force by the AE pulser 70 in accordance with a stop number which is determined by the camera body and rotates the AE motor 62.

The new lens can provide an AF coupler 73 which drives a focus lens so that the AF motor of the camera body can perform the focusing operation.

The structure of the mount portion which connects the new body 1 and the new lens 2 is described along with the position of electric contacts in the following. In this camera system, a bayonet mount system which connects a lens and a body by engaging a plurality of nails provided on both of the mount and the body mount.

Fig. 2 shows a front view of the new body 1. On the lens mount opening, a mount ring 30 is fixed by five screws 31a to 31e.

On the mount ring 30, a body side contact Fmax1 32, a body side contact Fmax2 33, a body side contact Fmax 3 34, a body side contact Fmin1 35, a body side contact Fmin2 36, and a body side contact Cont 38 are provided, each of which is insulated from the mount ring 30 and protrudes therefrom. A body side contact A/M 37 is provided in the manner that it does not protrude from the mount ring 30 and is insulated from the ring 30 (see Fig. 4).

A body side contact V_{Batt} 40 and a body side contact Vdd 41 are provided inside the mount ring 30.

A pin 42 is used to prevent a lens from rotating. The pin 42 normally protrudes by a spring force , and is inserted into an engagement hole of the lens, whereby prohibiting the lens being mounted from rotating. By pushing a lever 43, the pin 42 is retracted into the mount ring 30 thereby allowing the lens to rotate.

As shown in Fig. 3, on the mount portion of the new lens 2, a mount ring 80 is fixed by five screws 81a to 81e.

On the mount ring 80, a lens side contact Fmax1 82, a lens side contact Fmax2 83, a lens side contact Fmax3 84, a lens side contact Fmin1 85, and a lens side contact Fmin2 86 are provided, each of which is insulated from the mount ring 80 and does not protrude therefrom.

A lens side contact Cont 87 and a lens side contact A/M 88 are provided in the manner that they protrude from the mount and are insulated from the ring 80 (see Fig. 5).

A lens side contact V_{Batt} 90 and a lens side contact Vdd 89 are provided inside the mount ring 80.

Moreover, an engagement hole 92 which prohibits the lens from rotating when the pin 42 is engaged is

provided on the mount ring 80. The afore-mentioned AF coupler 73 is also provided on the mount ring.

In the above contact arrangement, when the new lens 2 is mounted on the new body 1, the corresponding contacts are electrically connected. The setting of protrusion and retraction of each contact is used to distinguish a combination state of a conventional camera system and a new camera system of the present invention as described later.

In the above example, two sets of contacts 39, 40 and 89, 90 are provided inside the mount ring. However, it is also possible to provide all the contacts on or inside the mount ring.

A new body circuit is described in accordance with more detailed circuit diagrams in the following.

Fig. 4 shows a circuit of the new body 1. At terminal V_{DD1} of the display CPU 11, the voltage of battery 22 is supplied as a constant voltage by a regulator 23 which is a backup by a super capacitor 24. The constant voltage is always supplied to terminal V_{DD1}.

Terminal P1 of the display CPU 11 is connected to a DC/DC converter 25 which turns on/off the power of the main CPU 10. Terminal P2 is connected to a photometry switch SWS which is turned on when the shutter button of the camera is pressed in a first step. Terminal P3 is connected to a release switch SWR which is turned on when the shutter button is pressed in a second step. Terminal P4 is connected to a lock switch SWL which is turned on so as to make the camera ready to photograph. Data of each switch SWS, SWR and SWL is input to the display CPU 11 through the Terminals P2, P3, and P4, respectively. While the lock switch SWL is turned on, when the photometry switch SWS or the release switch SWR is turned on and when data on the lens side is input to the main CPU 10, the DC/DC converter 25 supplies a power to terminal V_{DD} of the main CPU 10 by a command from the display CPU 11 and activates them.

Terminal P5 of the display CPU 11 is connected to a mode switch SWM which selects photographing modes such as a programmed photographing mode, an automatic photographing mode, and a manual photographing mode when it is turned on. Terminal P6 is connected to a drive switch SWDr which selects drive modes such as a single shot mode and a continuous shot mode when it is turned on. Terminal P7 is connected to an exposure compensation switch SWXv which allows exposure to be compensated when it is turned on. When one of the switches SWH, SWDr and SWX_v connected to the terminals P5, P6 and P7 is turned on, by operating an up-count switch SWUp connected to the terminal P8 or a down-count switch SWDn which is connected to terminal P9, the individual settings changeable by the switches SWM and SWDr and SWXv can be changed.

A group of terminals P_{SEG} serve to operate the LCD panel 12. When the lock switch SWL is turned on, the LCD panel 12 displays various data necessary for photographing through the set of terminals P_{SEG}.

Terminal P10 of the display CPU 11 is connected to the body side contact Fmax1 32; terminal P11 to the body side contact Fmax2 33; terminal P12 to the body side contact Fmax3 34; terminal P13 to the body side contact Fmin1 35; terminal P14 to the body sidebcontact Fmin2 36; terminal P15 to the body side contact A/M 37; terminal P16 to the body side contact Cont 38; terminal P17 to the body side contact Vdd 39; terminal P18 to a switch circuit 26.

In addition, the switch circuit 26 serves to switch between the body side contact V_{BATT} 40 and the battery 22 by the signal state H (high)/L (low) of terminal P18. A body side contact Gnd 41 is connected to the ground terminal of the battery 22 along with terminal Gnd of the display CPU 11.

The body side contact Gnd 41 is electrically connected to the mount ring 30.

The display CPU 11 and the main CPU 10 transfer each other data comprising 8-bit command codes as listed in TABLE 1 through a serial clock terminal SCK, a serial-in terminal SI, and a serial-out terminal SO.

In TABLE 1, codes 0 to 3 which are output from the display CPU 11 to the main CPU 10 are set depending on the conditions of the switches provided on the new body, and the data of the lens ROM and the lens CPU. Codes 4 to 7 are data being input from the display CPU to the main CPU and are set in accordance with data measured by a photometer, an object distance measuring device, and so forth under control of the main CPU 10.

A group of PA contacts of the main CPU 10 is connected to the A/D circuit 15 for photometry; a group of PB contacts to the exposure control circuit 16, a group of PC contacts to the CCD process circuit 18; a group of PD contacts to the AF motor control circuit; a group of PE contacts to the AF pulser 21; a group of PF contacts to the DX input circuit 13. In addition, the A/D circuit 15 is connected to the light receiver 14; the CCD process circuit 18 to the AF CCD 17, the AF motor control circuit 20 to the AF motor 19 in the camera body as described above.

Terminal P20 of the main CPU 10 is connected to a first AF switch SW_{AF1} which switches between an automatic mode which drives a focusing operation by the AF motor 19 and a manual mode where the user manually performs the focusing operation. Terminal P21 is connected to a second AF switch SW_{AF2} which switches between a focusing priority mode and a release priority mode for a shutter release operation. The

first AF switch SW_{AF1} is mechanically interlocked with the second AF switch so that when the first AF switch is set in the manual mode, the second AF switch SW_{AF1} is set into the release priority mode.

Fig. 5 shows a circuit in the new lens 2. The lens side contact V_{BATT} 90 is connected to the motor drive sections 63, 64 and 65. By switching between these drive sections 63, 64 and 65, power is supplied directly to the motors 60, 61 or 62 through the contact V_{BATT} 90 from the battery 22 in the camera body, respectively. The motor drive sections 63, 64 and 65 are connected to the terminals PH, PI and PJ of the lens CPU 66, respectively, so as to control them. The pulsers 68, 69 and 70 are connected to terminals P20, P21 and P22, respectively, thereby the driving amount of each motor is detected and input to the lens CPU 66.

The lens side contact Vdd 89 supplies power from the body side display CPU 51 to terminal Vdd of the lens CPU 66. and to a reset circuit consisting of resistor R, diode D and capacitor C.

The reset circuit has a specific time constant corresponding to the resistor R and the capacitor C. When the power supply voltage is stable after Vdd is applied and a specific time period corresponding to the time constant elapses, the reset circuit causes the signal state at terminal $\overline{RESET}$ of the lens CPU 66 to be changed from active (L) to inactive (H) and the program of the lens CPU 66 will be started.

This lens CPU 66 controls each motor driving section in the lens in accordance with information sent from the lens ROM 60 and from the body and transfers set data to the camera body. In the RAM of the lens CPU 66, data as listed in TABLE 2 is set, which functions as a third information transfer means. The addresses 0 to 3 of the lens CPU 66 are set by the lens CPU 66 with the states of lens side switches, data of lens ROM, and input data from pulsers. The addresses 4 to 7 are set in accordance with data being input from the body side main CPU 10 through the display CPU 11.

In addition, the addresses 1 to 4 of the lens CPU 66 are an area which stores data for determining the number of drive pulses (K-value, Kval) for a focusing lens per image surface moving unit which varies depending on the focal length. This data is computed from data of the lens ROM 07 and outputs from the PZ pulser and zoom code plate.

In a conventional zoom lens, the K-value has been determined by length data of a zoom code range in a lens ROM which is addressed by the same zoom code plate. Contrary to this, in the new lens 2, the area of the same zoom code range can be divided into smaller steps by PZ pulses which are output from the PZ pulsers.

By means of the higher number of steps a more precise AF control can be performed.

Terminals P23 to P27 of lens CPU 66 are provided on the lens wherein terminal P23 is connected to a third AF switch SW_{AF3} which switches between an automatic mode and a manual mode of the auto focus operation; terminal P24 is connected to a zoom selection switch SW_{PZ1} which selects between a motor drive mode and a manual mode of the zooming operation; terminal P25 is connected to an image magnification switch SW_{PZ2} which serves to automatically perform the zooming operation depending on the movement relative to a subject so as to keep the image magnification thereof constant; terminal P26 is connected to a F side zoom switch SW_{PZT} which causes the PZ motor 69 to move the photographic lens in the direction where the focal length thereof increases, and terminal P27 is connected to the zoom switch SW_{PZW} which causes the PZ motor 69 to move the lens in the direction where the focal length thereof decreases.

The lens CPU 66 provides terminal INT where electric signals which interrupt an execution of the program thereof; terminal SCK where a serial clock from the body side display CPU 11 is input; terminal SI/SO which transfers data in serial; and terminal $\overline{RDY}$ which synchronizes a serial communication of the lens CPU 66 with peripheral devices.

The terminal INT allows an interrupt of the lens CPU 66 to be enabled when the signal state thereof is changed from L to H after a reset operation. When the serial communication is enabled, the signal state of terminal $\overline{RDY}$ is changed to L and the communication enable state is transferred to the body side display CPU 11.

In addition, the zoom code plate 71 is connected to both the group of PK terminals of the lens CPU 66 and the group of PL terminals of the lens ROM 67. The distance code plate 72 is connected to the set of PM terminals of the lens ROM, thereby focal length information and object distance information corresponding to the actual lens conditions are input.

The lens ROM 67 stores information intrinsic to the photographic lens such as the minimum F number, the maximum F number, and the amount of change of F number caused by the zooming operation. The lens ROM 67 outputs data under control of the lens CPU 66 or of the body side CPU. As described in the example, the high order addresses of the lens ROM 67 are assigned in accordance with the zoom code detected from the zoom code plate 71. On the other hand, the low order addresses are assigned by counting clocks being input from terminal SCK.

The lens ROM 67 is to be regarded as a second information transfer means.

The lens side Fmax1 contact 82 is connected to terminal RESET of the lens ROM 67 and to terminal INT of the lens CPU 66. The lens side contact Fmax2 83 is connected to the lens ROM 67 and to terminal SCK of the lens CPU 66. The lens side contact Fmax3 84 is connected to terminal SO of the lens ROM 67 and to terminal SI/SO of the lens CPU 66. The lens side contact Fmin1 85 is connected to terminal RDY of the lens CPU 66.

The contacts 82 to 85 are connected to the emitters of PNP transistors Tr1 to Tr4. The bases of the PNP transistors Tr1 to Tr4 are connected selectively to contact Cont 87 or to the emitter through a fuse terminal. The collectors of the PNP transistors Tr1 to Tr4 are connected to a contact Gnd. It is also possible to provide the fuses between the emitters and the contacts 82 to 85.

While a voltage is applied to each contact 82 to 85, when the potential of the contact Cont 87 equals that of the contact Gnd, each transistor is turned on, so that the contaxts Fmax1, Fmax3, and Fmin1 which are in the connection state go L (low level) and the contact Fmax2 which is in the non-connection state goes H (high level). In other words, one memory cell or ROM is provided at each contact 82 to 85. Therefore, by connecting the fuse which is connected to the base of each transistor to the contact Cont 87 or emitter, one bit of information can be stored at each contact 82 to 85. It is also possible to provide these transistors in the lens ROM.

The lens side contact Cont 87 is connected to terminal Vc of the lens ROM 67 which supplies the power supply voltage of the lens ROM 67 from the camera body. When the power is supplied, the lens ROM functions.

The lens side contact A/M 89 is connected to a line with a ground potential connected to the lens side contact Gnd 88 through a diaphragm changing switch SWA/M which is switched between an automatic mode and a manual mode of the operation by turning the diaphram ring on the lens.

The lens side contact Fmin2 86 is grounded through a fuse 74 as a fixed information section which is the same as that provided in a conventional AE lens described later. Depending on whether the fuse is present or absent, one bit of fixed information is transferred to the camera body. The lens side contact Fmin2 86 contacts Fmaxl 82 to Fmax3 84, and contact Fmin1 85 provides data as listed in TABLE 9 to TABLE 11, and can be regarded as a first information transfer means.

The lens side contact Gnd 91 is electrically connected to the mount ring 80. When the lens is mounted on the camera, the contact 91 is electrically connected to the mount ring 30 of the body.

Combinations of the new lens, new body, conventional type lens, and conventional type body are described in the following.

Fig. 6 shows a block diagram wherein an AEAF (Auto Exposure Auto Focus) lens 3 which provides a conventional auto focus function is mounted on the new body 1.

The AEAF lens 3 provides a lens ROM 67 and an AF coupler 73 which drives a lens for the focusing operation by the AF motor 19 in the camera body.

In addition, as shown in Fig. 7, the AEAF lens 3 provides lens side contacts Fmax1 82 to Fmax3 84 which transfer a minimum F number as 3-bit information when a terminal Cont 87 is gournded; a first information transfer means consisting of contacts Fmin1 85 and Fmin2 86 which transfer a maximum F number as 2-bit information; and a second information transfer means including the lens ROM 67 which can read data by the new body or the conventional type AEAF body CPU with the AEAF function. The arrangement of the contacts is shown in Fig. 8.

When the AEAF lens 3 is mounted on the new body 1, except for two contacts of the new body 1, namely, contact Vdd 39 and contact V_{BATT} 40, the corresponding contacts of the lens side and the body side are connected to each other, thereby the body can receive second information that the lens ROM stores.

A conventional AEAF body equipped with an auto focus function and an auto exposure function does not, unlike the new body, provide Vdd and V_{BATT} as the arrangement of the contacts shows in Fig. 11. Since the AEAF body is the same as the new body at least in the electric circuit diagram except that the former body does not need the switch circuit connected to the V_{BATT} contact, the drawing of the AEAF body is omitted.

When the new lens 2 is mounted on the AEAF body, since the body does not provide the Vdd contact and V_{BATT} contact, the lens CPU and each motor driving section in the lens do not function. However, because the AF coupler of the body is connected to that of the lens, the same operations as the conventional AEAF system can be performed. In addition, data of the lens ROM can be transferred to the body.

Fig. 10 is a circuit diagram of a conventional AE body which provides only an AE function. This AE body provides contacts Fmax1 32 to Fmax3 34, contacts Fmin1 35 and Fmin2 36, and a contact A/M 38.

When the new lens is mounted on this AE body, the contact Cont 87 which protrudes from the mount ring of the lens touches the mount ring of the body and the potential of the contact Cont 87 equals to that of the ground. When a voltage is applied to each contact, the contacts Fmax1, Fmax3, and Fmin2 go L and the contact Fmax2 goes H, thereby information of minimum F value $F_{NO} = 2.0$ and maximum $F_{NO} = 22$ listed in TABLE 9 and TABLE 10 is provided.

Fig. 11 shows a circuit of an AE lens 4 which provides the AE function only. In this lens, each contact provides one bit of information. Between a contact A/M 87 and the ground potential, a diaphragm selection switch SWA/M is connected. For the other contacts, fuses which provide fixed information are provided. When this AE lens is mounted on the new body 1, a minimum F number, a maximum F number, and information relating to switching between an automatic mode and a manual mode of a diaphragm operation are transferred to the body through the contacts Fmax1 82 to Fmax3 84, Fmin1 85, Fmin2 86 and A/M 88.

Referring to Figs. 12 to 22, the operation of the new system constructed as explained above is described. In the following description, each program of the display CPU 11, the main CPU 10, and the lens CPU 66 will be separately described.

Fig. 12 shows a timer routine of the display CPU 11.

The display CPU 11 detects whether the lock switch state is ON or OFF in steps 1 and 2 (termed S.1 and S.2 hereinafter and in the drawings); when the lock switch is turned OFF, it prohibits a switch interrupt and turns off the power of the LCD panel 12 in S.3 and S.4; and waits until the lock switch SWL is turned ON while performing the timer routine in a period of 125 ms in S.5 to S.6 of the timer process.

When the lock switch is turned ON, the display CPU 11 detects the type of the lens being mounted by calling a data input process shown in Fig. 13 in S.8 and also detects whether the auto focus mode has been selected by calling an AF determination process shown in Fig. 15 in S.9.

The data input process subroutine causes each port which is used for communication with the lens to enter the input mode in S.30 and detects the level of the contact Cont 38 in S.31 and S.32. When the lens does not have the contact Cont, namely, when the AE lens is mounted, since the contact Cont 37 of the body touches the mount ring, the ground potential will be effective (namely, L). Consequently, this subroutine reads the minimum F number, the maximum F number, and the stop A/M switching state as 6-bit parallel data in S.33, sets flag F_{AE} which represents that the lens being mounted is an AE lens in S.34, and returns to the timer routine.

When the contact Cont has high (H) level, the data input process subroutine causes the signal level to be changed to low (L) level in S.35 and detects the signal levels of other contacts in S.36 and S.37. When the signal levels of all the contacts being detected are high (H), this subroutine determines that the lens is not mounted, sets flag F_{NO} which represents that the lens has not been mounted in S.38, and then returns to the timer subroutine.

The decision in S.37 is negated when the new lens or an AEAF lens has been mounted. Then, the signal level of the contact Cont is changed to high (H), in S.39 and the signal level of other contacts will be detected in S.40 and 41. When the signal levels of all the contacts being detected are not high (H), the data input routine determines that the lens CPU, the lens ROM or the lens is defective, sets flag F_{NO} which represents that the lens has not been mounted in S.38, and then returns to the timer routine.

When the data input routine determines that the signal levels of all the contacts are high in S.41, it determines that a lens which has a lens CPU or a lens ROM has been mounted, turns on the power of the lens CPU in S.42 to S.44, changes the mode for the contacts Fmax1 to Fmax3 from the port mode to the serial communication mode in S.45, and waits until the lens CPU becomes ready to communicate in S.46.

When the lens CPU becomes ready to communicate, the routine sends an address of the lens CPU in S.47 and after the lens CPU becomes ready to communicate again, it inputs data of the lens CPU in S.49. This routine detects the 2/3 code of bits 5 to 7 of address 0 of the lens CPU at S.50 and when it is OK, sets flag F_{CPU} which represents that the lens CPU is provided in S.51. The 2/3 code is a code in which 2 of 3 bits are set to "1" as listed in TABLE 3. This code serves to distinguish whether the lens being mounted has a lens CPU or not.

In S.52 and S.53, the routine causes the signal state of the contact Fmax1 to go low (L) and inputs data of the lens ROM; when F_{CPU} is "1", it returns to the display timer CPU routine; when F_{CPU} is 0, it detects the 2/5 code of the bits 3 to 7 of address 0, and when it is OK, it sets flag F_{ROM} which represents that the lens is not mounted; when it is not OK, it sets flag F_{NO} which represents that the lens is not mounted, and returns to the timer routine (S.54 to S.57).

Fig. 14 shows a timing chart of the data input process described above wherein Fig. 14 (a) represents that the AEAF lens which provides the lens ROM is mounted. In this case, the routine detects the signal level of the contact Cont at t1 (S.31), changes the signal level of terminal P10 to L at t2 (S.52), and reads data of lens ROM from t3 (S.53).

Fig. 14 (b) shows a data input process where the new lens which has the lens CPU is mounted in this case. at t1 this process performs the same operation as the above subroutine does. However, at t2 the process changes the signal level of the contact Cont to Low and inputs the signal level of each contact (S.36); and when they are not all H at t3, changes the signal level of the contact Cont to H (S.39). When all the signal levels of terminals P10 to P13 and P17 are H, the process changes the signal state of the contact Fmax1 to L, the contact Vdd to H at t4 (S.42 and S.43); at t5 the signal level of the contact Fmax1 to H (S.44); at t6 if the signal level of the contact Fmin1 is L (S.46), at t7 the process starts a serial communication (S.47).

Fig. 15 shows the AF determination subroutine which is called in S.9 of the timer subroutine. First, the subroutine determines which type of lens is mounted by the flag being set in the data input process described above and performs a process corresponding to the lens being mounted in S.60 and S.61. When the lens has the lens CPU, the subroutine references Add 0 of bit 3 of the lens CPU in S.62. This bit is set by the lens CPU when the third AF switch position is changed. When the switch position is "1", the subroutine further detects the state of the first AF switch of the body in S.63. When the state of both switches is ON, the subroutine sets flag F_{AF} so as to indicate that the auto focus mode takes place in S.64. When the state of one of the switches is OFF, the subroutine clears the flag F_{AF} so as to indicate that the manual focus mode takes place.

On the other hand, when the AEAF lens which has a lens ROM is mounted, the first AF switch of the body determines whether the auto mode or the manual mode takes place. When the AE lens which does not provide both the lens CPU and lens ROM is mounted, the manual focus mode is set.

After the process of the above subroutine is completed, when returning to the timer routine, the display CPU 11 permits a switch interrupt in S.10 and causes the LCD panel to indicate the AF set state corresponding to the flag state described above.

While a lens which provides a lens CPU is mounted, when the lens issues a power hold request in S.14 and S.15, the timer routine changes the signal state of P1 to L and starts the main CPU 10 at S.16.

In S.17 to S.24, when the mode switch, the drive switch, the exposure compensation switch, and the up switch and the down switch are provided and operated, a process which changes the operation mode and display indication thereof is conducted.

When such switches are not operated, the processes from S.5 to S.7 are conducted and the processes end.

While the timer routine allows "SWS and R interrupt", when the photometry switch and the release switch are turned on, an interrupt process shown in Fig. 18 is executed.

In this SWS and R interrupt process, the process prohibits a further SWS and R interrupt in S.70, turns on the power of the main CPU, and permits a serial interrupt.

The serial interrupt is a flow consisting of two steps of a command input operation in S.90 and a related process operation in S.91. This flow serves to communicate with the main CPU in accordance with command codes listed in TABLE 1 and to conduct a required process.

While both the lock switch SWL and the photometry switch SWS are turned on, the SWS and R interrupt process repeats the processes in S.73 to S.78 so as to input information which is changed time by time and to perform the set change process for the mode, the drive, and the exposure compensation which are same as those conducted in the timer routine S.17 to S.24.

When one of the lock switch SWL and the photometry switch SWS is turned off, the interrupt process routine turns off the power of the main CPU, sets the timer, permits a timer interrupt, and stops the process in S.79 to S.82.

Referring to Figs. 18 to 20, a program installed in the main CPU 10 is described in the following.

When the DC.DC converter 25 is turned on and then the power of the main CPU is turned on, the main CPU is initialized in S.100 and determines whether the photometry switch SWS or the release switch SWR is turned on in S.101.

When both the switches SWS and SWR are turned off, the program reads command code "1" transferred from the display CPU 11 and determines whether the lens issues a power hold request from the state of Add 0,bit 4 of the lens CPU. When the lens does not issue the power hold request, the main CPU requests the display CPU 11 to turn off the power hold in S.104 and terminates the process. When the lens issues the power hold request, the program sets bit 1 of command code 5 to "1" and transfers it to the display CPU 11 in S.105.

Consequently, the display CPU receives the data, sets P18 to H, turns on the switch circuit, and then turns on the power V_{BATT} of the motor driving section of the lens.

When the photometry switch SWS or the release switch SWR is turned on, the program transfers a command which requests the display CPU 11 to turn on the power of the lens CPU, the inputs photometry

A.D. the DX information, the data the lens provides, the shutter speed set by the body, and the diaphragm value from the display CPU in S.107 to S.109 and computes Tv (Time Value) and Av (Aperture Value) in S.110.

The main CPU 10 transfers information of Tv and Av being computed to the display CPU 11 so as to display them on the LCD panel 12.

The program determines whether the release switch SWR is turned ON or OFF in S.112. While the release switch is turned ON, when AF is in the manual state or the release priority mode is performed, the control advances to "B" described later so as to conduct a release process. When the release switch SWR is turned OFF or when it is turned ON while AF is in the auto mode and the focusing priority mode is performed, the program causes the distance measuring process to start.

The main CPU 10 computes the amount of defocus by inputting CCD data, determines the focusing state from the data and indicates the result in the finder in S.115 to S.117.

When a subject is not focused, the program advances from S.118 to "A" described later so as to perform an AF process. When the amount of defocusing length is "0" in the focusing priority mode, the program performs the focus lock operation when the release switch SWR is turned ON while the photometry switch SWS is turned ON in S.120 and S.121.

In the release priority mode in which the switch SW_{AF2} is on, when the release switch SWR is turned ON, the program advances from S. 122 to "B" (S.138). When the release switch SWR is turned OFF, the program advances the process to "A" (S.123) rather than activating the release lock operation.

Fig. 19 shows an AF process of the main flow of the main CPU.

When focusing is in the manual mode, the program returns back to S.101 so as to continue the process rather than driving the lens (S.122). In the manual mode, the release priority mode automatically takes place. Thus, when the subject is not focused while the photometry switch SWS is turned ON and the release switch SWR is turned OFF, the program continuously executes the process in a loop until it determines that the release switch SWR is turned ON in S.112. When the release switch SWR is turned ON, the program exits from S.113 to "B" so as to perform the release process. When the object is focused by manually operating the lens, the program may exit from S.119 and S.122 to "B".

When the focusing is in the auto mode, the program selects one of five lens drive methods depending on the performance of a CPU being mounted on the lens, as described below.

The first case (combination) is that a conventional AEAF lens which provides a lens ROM is mounted. In this case, like the conventional method, the main CPU in the body computes drive pulses by the amount of the defocusing length in S.125 and the AF motor of the body drives the lens in S.127 to S.129.

The second and third cases (combinations) are that although a lens has a lens CPU, its performance is not so high. In this case, the program advances from S.130 to S.125 so that the main CPU in the body computes the number of pulses depending on the amount of the defocusing length. After that, the program selects whether to drive the focusing lens from the lens side or from the body side in S.132.

In the second case, the AF motor in the body drives the focusing lens. Consequently, like the first case, the program performs the processes in S.127 to S.129.

In the third case, since the focusing lens is driven by an AF motor provided in the lens, the lens CPU drives the AF motor in accordance with the number of pulses transferred in S.131. The main CPU waits until the lens movement completion information is transferred from the lens CPU in S.133 and S.134 and after that, the program advances to "C".

When the AF motor in the body drives the focusing lens, it is not necessary to transfer the number of pulses for AF to the lens. However, the program transfers the number of pulses to the lens CPU in S.131 which computes the image magnification using the amount of moving length of the focusing lens performing the constant image magnification control operation. The constant image magnification control operation is to vary the magnification of the lens so that the size of the subject image on a film is maintained constant. This operation is conducted in the manner that the program detects a change of the magnification by the amount of defocus after the subject which has been focused is moved, converts the change of magnification into PZ motor drive pulsers, and controls the PZ motor.

The fourth and fifth cases (combinations) are that a lens being mounted has a very high performance. In these cases, request data of the lens CPU is the amount of defocusing length. Even in the conventional system, although a program which compensates a nonlinear characteristic between the amount of defocus and the amount of driving length of lens has been installed, the system reads compensation data in a lens ROM and causes the CPU in the body to compute the compensation. Consequently, the CPU should have a general purpose function. On the contrary, in the fourth and fifth cases, when the lens CPU converts the amount of defocus into pulses, even for a lens with much complicated linearity, suitable conversion can be performed, resulting in a more precise AF control operation than in the conventional system.

In the fourth case, the program inputs the number of drive pulses computed by the lens CPU to the main CPU in S.137 so as to drive the AF motor in the body.

In the fifth case, since the program drives the AF motor in the lens in accordance with drive pulses computed by the lens CPU, the main CPU waits until the lens moving operation is completed in S.133 and S.134; the program returns back to "C" and then continues the process.

Fig. 20 shows a release process of the main CPU main flow.

When the program advances from the main flow of the main CPU shown in Fig. 18 to the process "B" shown in Fig. 22, only while a lens which does not provide a lens CPU is employed, the program controls the diaphragm and the shutter speed in the body so as to perform the exposure operation. When a lens which provides a lens CPU is employed, the program determines whether to perform the diaphragm control in the lens or from the body by data of lens ROM. When the diaphragm control is performed in the lens, the program transfers the number of steps of the AE stop-down operation computed by the main CPU to the lens CPU and issues a stop-down start command and performs the exposure operation with the shutter speed controlled from the body.

After the exposure operation is completed, the program causes the main CPU to drive the wind motor for winding the film in S.144. When the drive C, namely, continuous shot mode takes place, the program immediately advances to "C" shown in Fig. 20 so as to continue the process. When the single shot mode takes place, the program waits until the release switch is turned OFF in S.146 and returns to "C".

Referring to Fig. 21 and 22, the operation of the lens CPU is described.

Fig. 21 is a main flow chart of the lens CPU. After the contact goes H by a command from the display CPU, the reset circuit works and the reset operation is released, resulting in activating the lens CPU.

The program initializes the lens CPU in S.200, reads data from the switch and the zoom code plate provided in the lens in S.201 and S.202, and stores it in a RAM.

The program sets the terminal SI/SO to the serial input mode in S.203 to S.205 so as to permit a serial interrupt and sets the contact RDY to L so as to inform the display CPU that the serial communication is enabled.

The program sets a timer so as to continue this process at an interval of 125 ms in S.206 to S.208 and completes the process one time.

Fig. 22 shows a flow chart of the serial interrupt process of the lens CPU which is executed when a serial interrupt from the display CPU of the body occurs.

The program sets the signal level of the contact RDY to H in S.210 which informs the display CPU that the serial communication is disabled, determines which address of the lens CPU in TABLE 2 accords with the signal being transferred from the display CPU and executes the process corresponding to the address in S.211.

When the program determines that the signal accords with Add 0 to 3, it outputs this data in series in S.213 and S.214. This data is set by the lens CPU in accordance with data of the switches and data of the lens ROM. After the data is output, the program sets the signal level of the contact RDY to L, changes the port which was changed to the output mode in S.213 and S.214 to the input mode, permits a serial interrupt, and returns back to the main flow so as to continue the process.

When the program determines that the signal accords with Add 5 to 7, it changes the contact SI/SO to the input mode in S.219 and S.220 so as to represent that the communication is enabled, inputs data in S.221, and advances to S.216. This data is transferred to the lens CPU from the main CPU through the display CPU.

When the program determines that the signal does not accord with Add 0 to 3 and Add 5 to 7 and an address which is not Add 4, namely Add 1 to 4 or an address which is not permitted, is specified, it advances to S.216 where a practical process is not conducted and then returns back to the main flow.

When data transferred from the display CPU accords with Add 4 of the lens CPU, a process in accordance with the bit is conducted. When bit 7 is "1", the program drives the PZ motor for performing the zooming operation and sets the moving completion bit in S.224 to S.227. When bit 6 is "1", the program drives the AF motor for performing the focusing operation and sets the moving completion bit in S.229 to S.232. When bit 5 is "1", the program drives the AE motor for performing the stop-down operation.

After the process of each motor is completed, the program advances to S.216 and S.217 and returns back to the main flow so as to perform the process.

As described above, the camera system of the present invention determines which type of lens is mounted on a body and inputs three kinds of data depending on the performance of the lens. Conversely, the lens supplies three steps of information depending on the performance of a body.

In addition, when the body and the lens both of which relate to the present invention are combined, by organically connecting the control means of the body and that of the lens, more precise information can be

transferred than in conventional camera systems. For example, more precise AF control operation is available.

TABLE 1

(Command Codes)								
Code	bit							
	7	6	5	4	3	2	1	0
0	Mode Drive				Exposure compensation			
1	Lens CPU Add 0 to 3							
2	Lens ROM Add 0 to 7							
3	Tv being set				Av being set			
4	Tv to be displayed				Av to be displayed			
5	ISO						Vbatt ON	PH request
6	Number of film shots					Winding information		
7	Lens CPU Add 4 to 7							

TABLE 2

(L-CPU)								
address	bit							
	7	6	5	4	3	2	1	0
0	2:3 code			PH request	AF A/M	PZ A/M		Lens O/C
1	Short focal length data							
2	Long focal length data							
3	Sf end	Lf end	AF N end	AF F end	PZ F	PZ S	PZ mv. comp.	AF mv. comp.
4	PZ start	AF start	AE st.-dn					
5	Amount of focal length (number of pulses)							
6	Amount of defocusing length (number of pulses)							
7	Number of AE stop-down steps (number of pulses)							
01	Number of start pulses in zoom code plate range Ph							
02	Pulse width in zoom code plate range Pw							
03	Start Kval Ka							
04	Kval calibration coefficient Kc							

TABLE 3

Add 0 2:3 code				
bit	7	6	5	
	1	1	0	RAM ver.1
	1	0	1	RAM ver.2
	0	1	1	RAM ver.3

TABLE 4

(L-ROM)								
	bit							
Add	7	6	5	4	3	2	1	0
0	2:5 code							
1	Lens data							
2	Kvalue data							
3	AF compensation amount data							
4	Release Av				Minimum Av			
5	Exposure compensation amount data							
6	Focal length data							
7	Distance code data							

TABLE 5

Add 0 bit					
7	6	5	4	3	2:5 code
0	0	0	1	1	Single lens
0	0	1	0	1	Zoom lens
0	0	1	1	0	Macro lens

TABLE 6

Add 0 bit 2, 1		
bit	bit	
0	0	ROM ver.1
0	1	ROM ver.2
1	0	ROM ver.3
1	1	ROM ver.4

TABLE 7

Add 0 bit 0	
0	Input mode
1	Input/output mode

TABLE 8

Add 2	
bit	
0	AF presence/absence
1	AE presence/absence
2	PZ presence/absence
3	AF drive type
4	AF data request
5	Pulse request
6	Defocus request
7	AE drive type

TABLE 9

Minimum F_{NO} information			
	Fmin		
F_{NO}	3	2	1
1.4	0	0	0
1.7	0	0	1
2	0	1	0
2.5	0	1	1
2.8	1	0	0
3.5	1	0	1
4	1	1	0
4.5	1	1	1

TABLE 10

Maximam F_{NO} information		
	Fmax	
F_{NO}	2	1
22	0	0
32	0	1
45	1	0

TABLE 11

A/M	0	1
Lens	Auto	Manu

Claims

1. A single-lens reflex camera system comprising a camera body and a lens unit which is interchangeably mounted to said camera body, said camera body including:
detector means for detecting a defocus amount based upon the condition of the subject image formed by light having passed through said lens unit;
first transfer means for transferring data related to the defocus amount detected by said detector means, to said lens unit, and
drive means for driving said lens unit, said lens unit including:
memory means having stored information intrinsic to the lens unit;

computer means for computing the driving amount of said lens unit corresponding to the defocus amount transferred by said first transfer means, with the information stored in said memory means; and
second transfer means for transferring the driving amount computed by said computer means, to said camera body,
wherein said drive means of said camera body is operated in accordance with said driving amount transferred by said second transfer means.

2. A camera body of a single-lens reflex camera, to which a lens unit is interchangeably mounted comprising:
detector means for detecting a defocus amount based upon the condition of the subject image formed by light having passed through said lens unit;
transfer means for transferring data related to the defocus amount detected by said detector means, to said lens unit;
receiving means for receiving data related to a driving amount of said lens unit corresponding to said defocus amount; and
drive means for driving said lens unit based upon said drive amount.

3. A lens unit of a single-lens reflex camera to be interchangeably mounted to a camera body, comprising:
memory means having stored information intrinsic to the lens unit;
receiving means for receiving data from the camera body, said data relating to a defocus amount detected based upon the condition of the subject image formed by light having passed through said lens unit;
computer means for computing a driving amount of said lens unit corresponding to said defocus amount with information stored in said memory means; and
transfer means for transferring said driving amount to the camera body.

4. A single-lens reflex camera system comprising a camera body and a lens unit which is interchangeably mounted to said camera body, said camera body including;
detector means for detecting a defocus amount based upon the condition of the subject image formed by light having passed through said lens unit;
computer means for computing a driving amount of said lens unit corresponding to the defocus amount detected by said detector means, with information stored in said lens unit; and
transfer means for transferring the driving amount computed by said computer means, to said lens unit, said lens unit including:
memory means having stored information intrinsic to the lens unit: and
drive means for driving the lens unit.

5. A camera body of a single-lens reflex camera, to which a lens unit is interchangeably mounted, which comprises:
detector means for detecting a defocus amount based upon the condition of the subject image formed by light having passed through said lens unit;
computer means for computing a driving amount of said lens unit corresponding to the defocus amount detected by said detector means;
drive means for driving said lens unit;
first determining means for determining whether said driving amount is to be computed by said computer means; and
second determining means for determining whether said lens unit is to be driven by said drive means.

6. A lens unit of a single-lens reflex camera, to be mounted on a camera body, comprising:
receiving means for receiving data from the camera body, said data relating to a defocus amount detected based upon the condition of the subject image formed by light having passed through said lens unit,
memory means having stored information intrinsic to the lens unit;
computer means for computing a driving amount of said lens unit corresponding to said defocus amount with information stored in said memory means; and
drive means for driving said lens unit in accordance with the driving amount computed by said computer means.

7. The camera body according to claim 5 wherein said first determining means determines whether said driving amount is to be computed by said computer means, depending upon the type of the lens unit mounted to said camera body.

8. The camera body according to claim 5 wherein said second determining means determines whether said lens unit is to be driven by said drive means based upon the type of the lens unit mounted to said camera body.

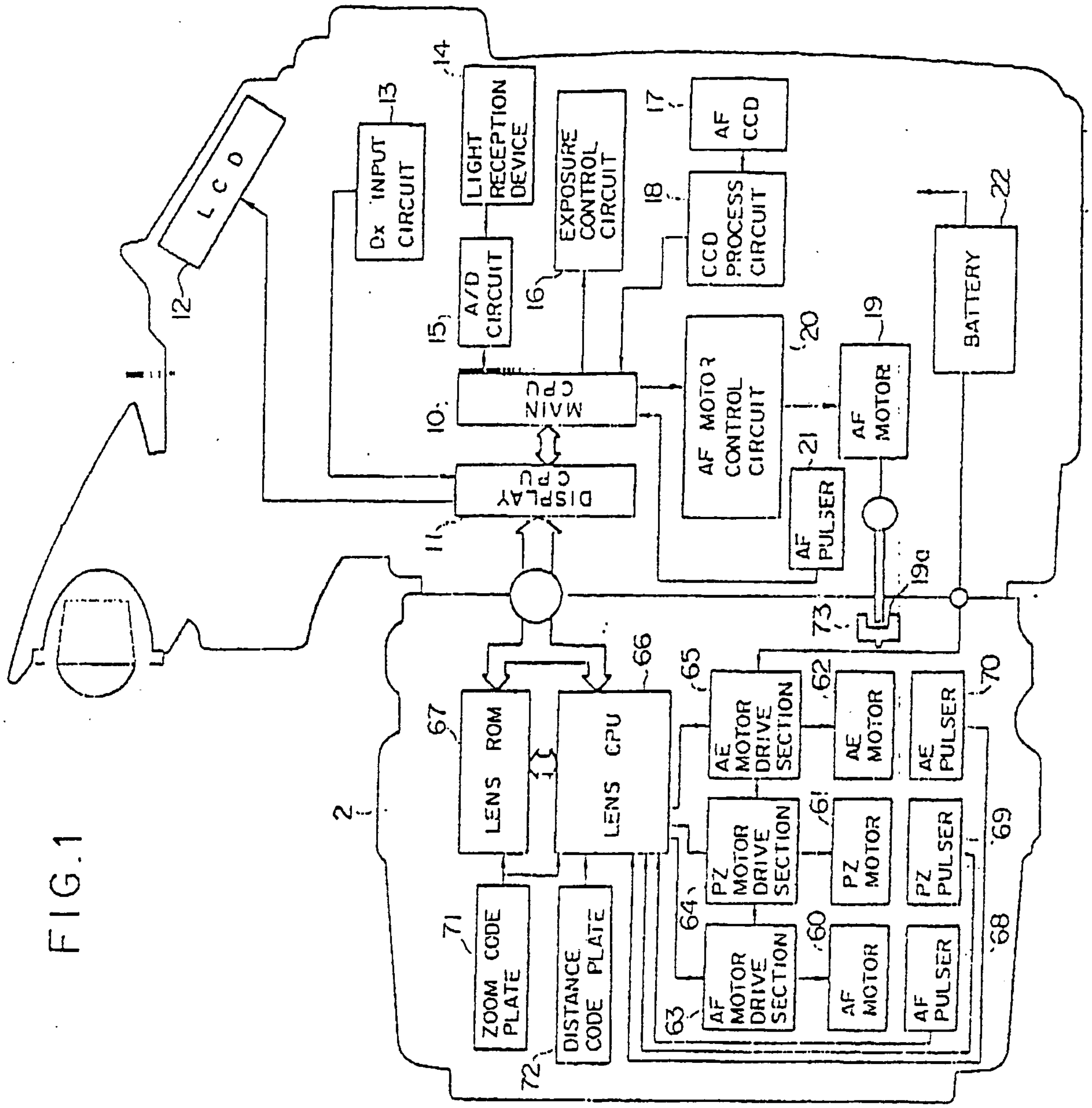

LCD
Dx INPUT CIRCUIT
LIGHT RECEPTION DEVICE
EXPOSURE CONTROL CIRCUIT
AF CCD
CCD PROCESS CIRCUIT
A/D CIRCUIT
MAIN CPU
DISPLAY CPU
AF MOTOR CONTROL CIRCUIT
AF MOTOR
AF PULSER
BATTERY
LENS ROM
LENS CPU
AE MOTOR DRIVE SECTION
AE MOTOR
AE PULSER
PZ MOTOR DRIVE SECTION
PZ MOTOR
PZ PULSER
AF MOTOR DRIVE SECTION
AF MOTOR
AF PULSER
ZOOM CODE PLATE
DISTANCE CODE PLATE

FIG.1

FIG.2

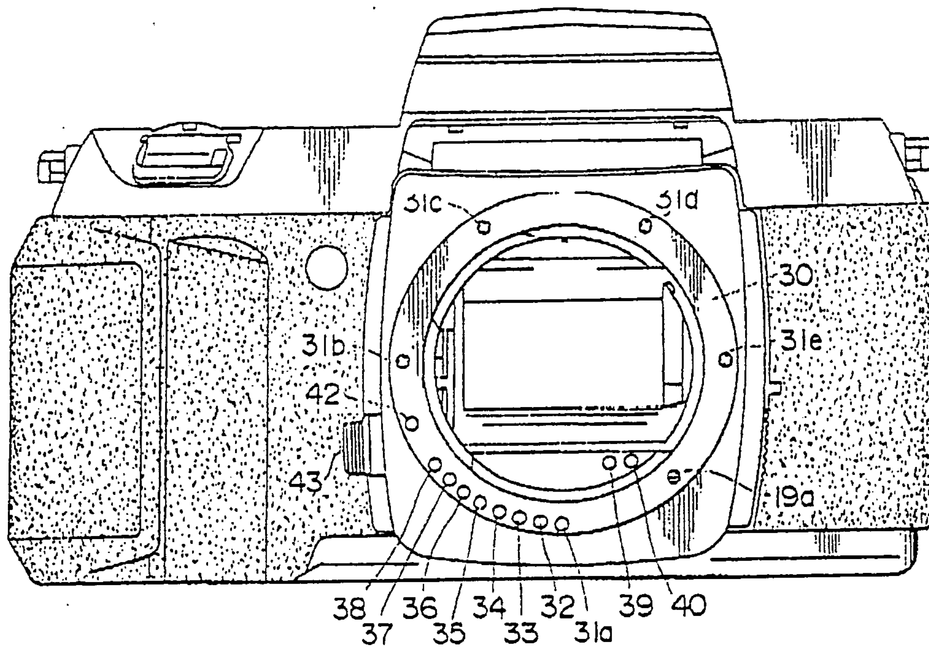
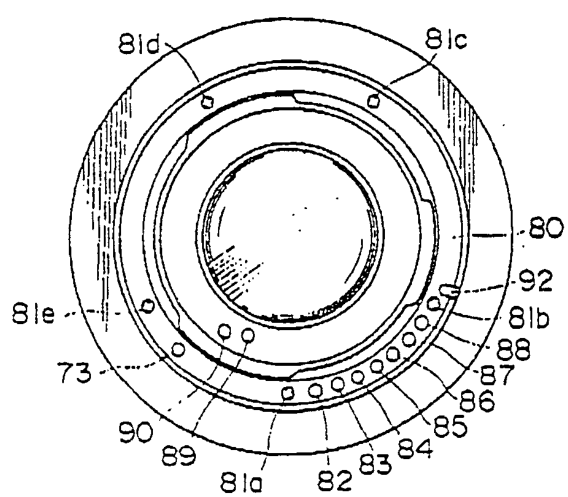
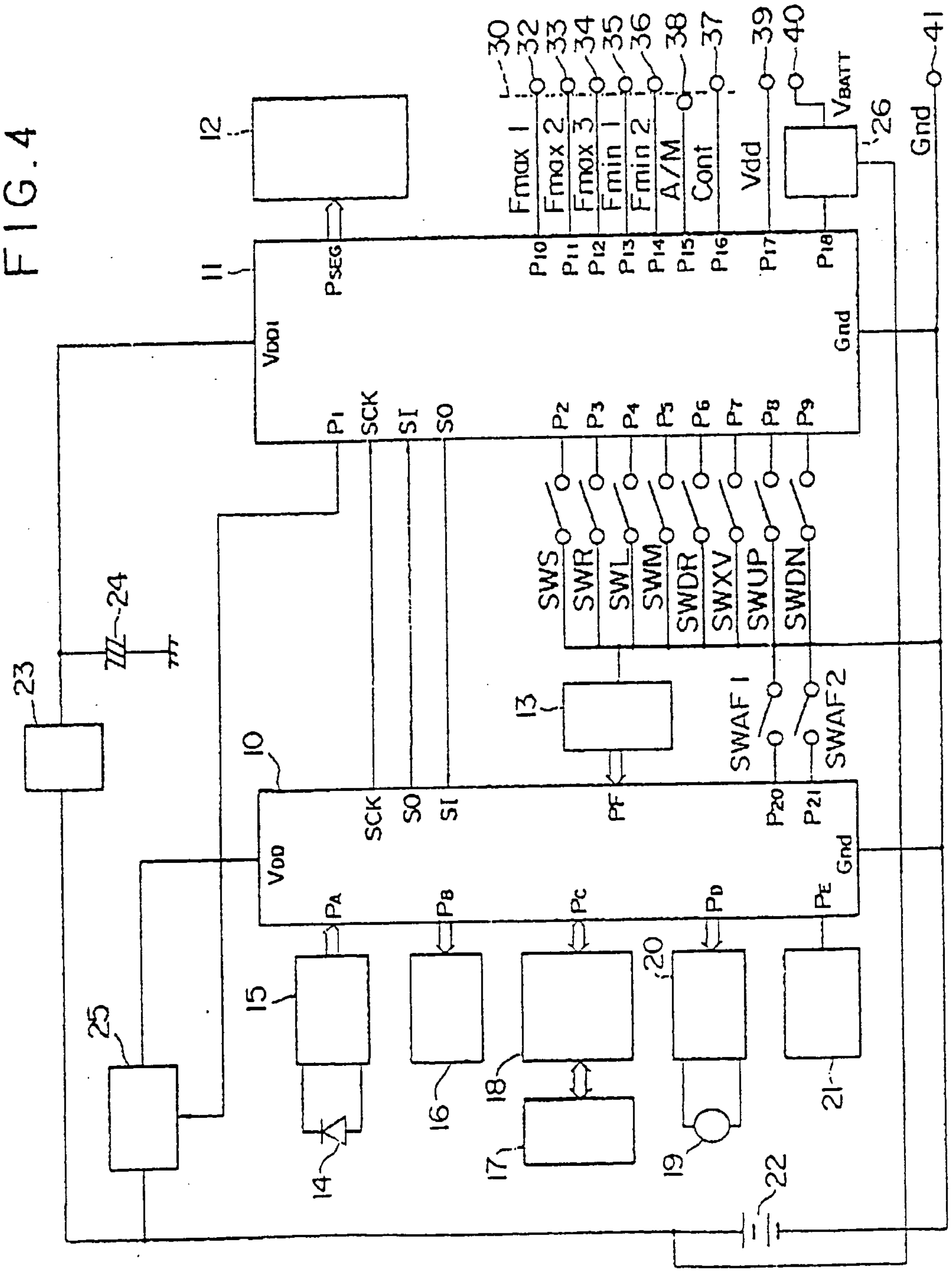

31c
31d
30
31b
31e
42
43
19a
38
37
36
35
34
33
32
31a
39
40

FIG.3


81d
81c
80
92
81e
81b
88
73
87
86
85
84
90
89
83
81a
82


10
11
12
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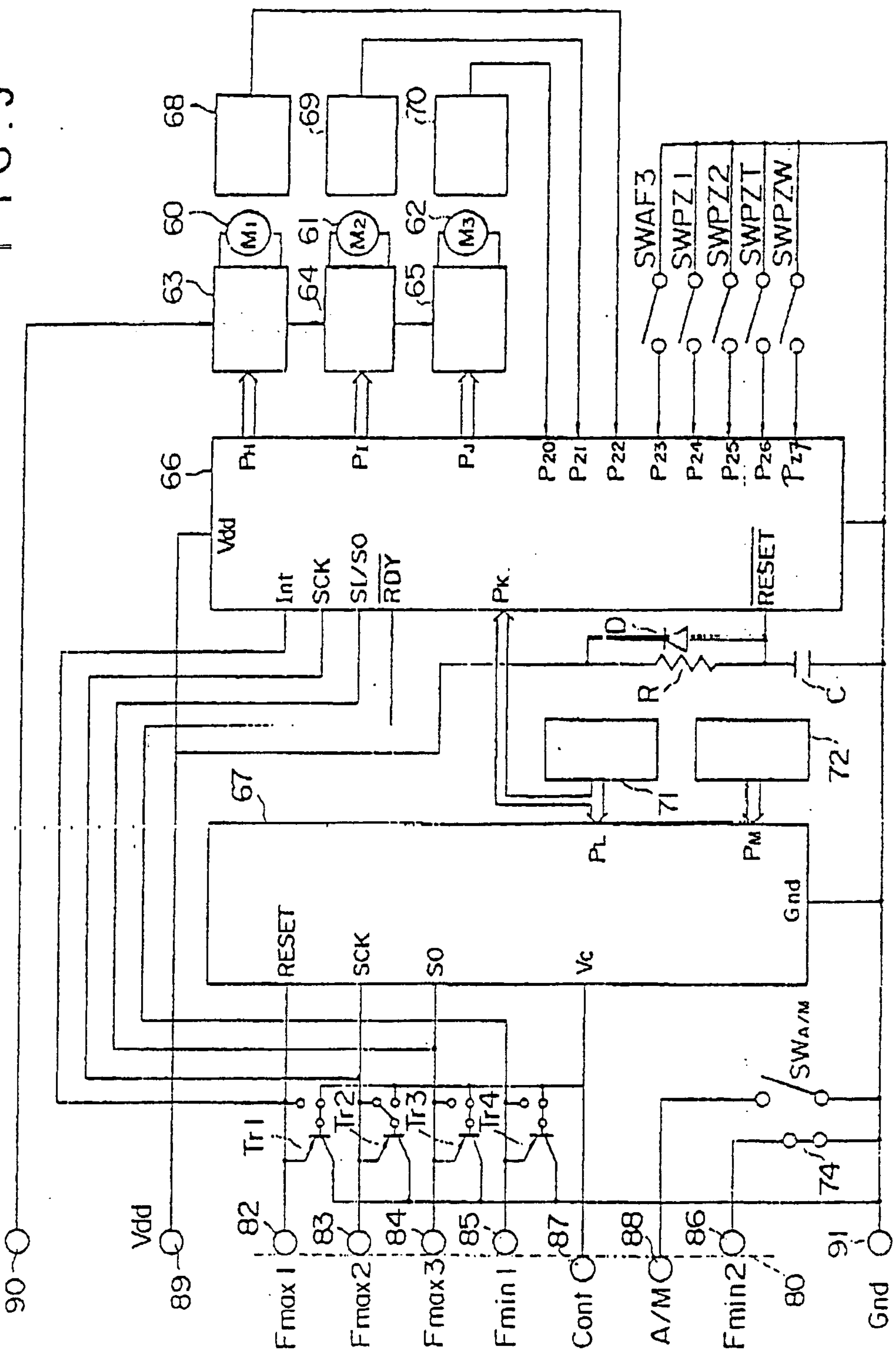
14
15
16
17
18
19
20
21
22
23
24
25
26
30
32
33
34
35
36
37
38
39
40
41
VDD1
PSEG
P1
SCK
SI
SO
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
P16
P17
P18
Gnd
Fmax 1
Fmax 2
Fmax 3
Fmin 1
Fmin 2
A/M
Cont
Vdd
VBATT
SWS
SWR
SWL
SWM
SWDR
SWXV
SWUP
SWDN
SWAF 1
SWAF2
VDD
SCK
SO
SI
PF
P20
P21
PA
PB
PC
PD
PE

FIG. 4

FIG. 5



68
69
70
60
61
62
63
64
65
66
67
71
72
M1
M2
M3
SWAF3
SWPZ1
SWPZ2
SWPZT
SWPZW
Vdd
Int
SCK
SI/SO
RDY
PK
RESET
PH
PI
PJ
P20
P21
P22
P23
P24
P25
P26
P27
D
R
C
PL
PM
Gnd
RESET
SCK
SO
Vc
SWA/M
Tr1
Tr2
Tr3
Tr4
74
VBATT
90
Vdd
89
82
83
84
85
87
88
86
80
91
Fmax1
Fmax2
Fmax3
Fmin1
Cont
A/M
Fmin2
Gnd

FIG. 6

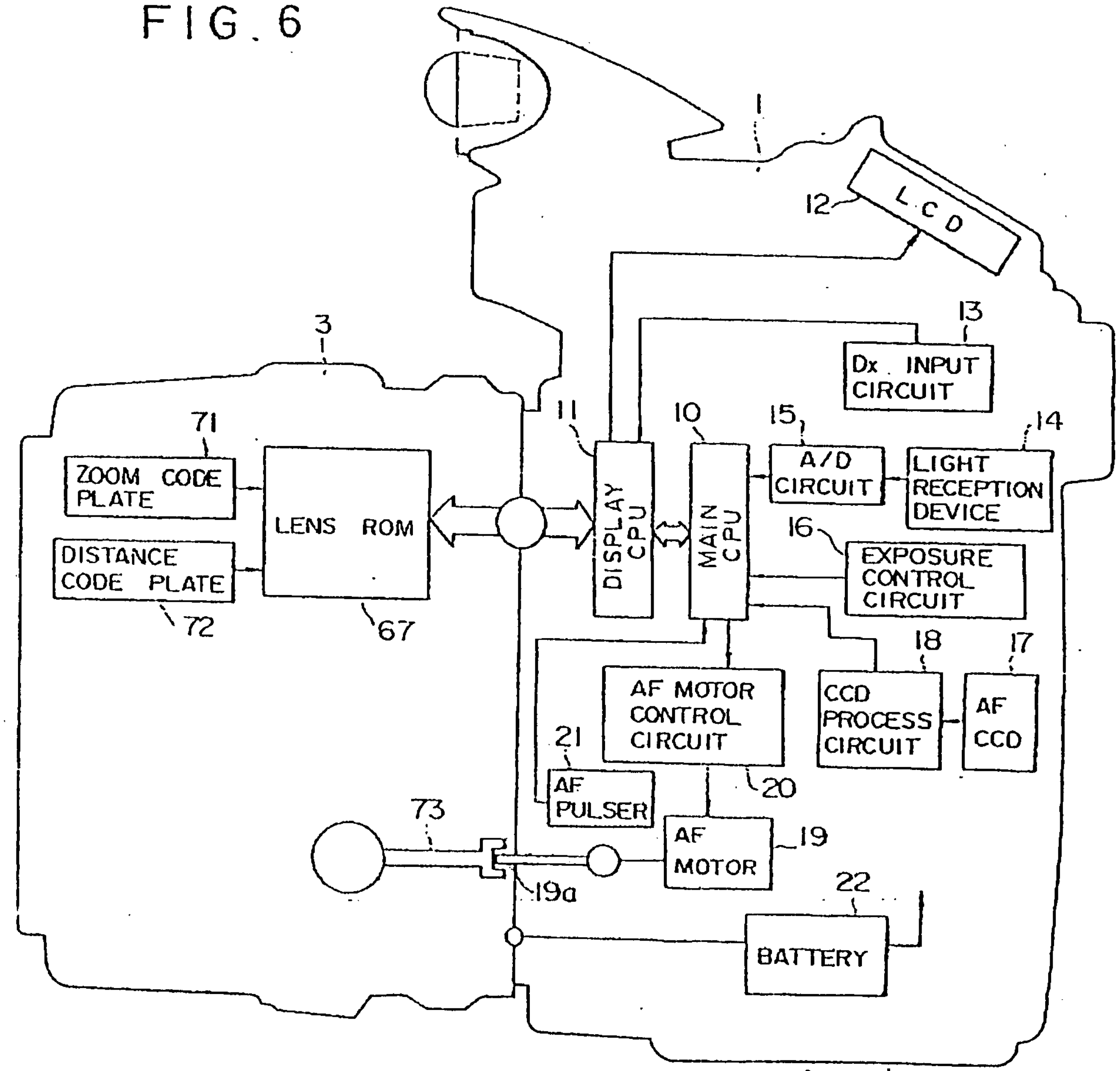

1
3
12
LCD
13
Dx. INPUT CIRCUIT
11
10
15
14
ZOOM CODE PLATE
71
LENS ROM
DISPLAY CPU
MAIN CPU
A/D CIRCUIT
LIGHT RECEPTION DEVICE
16
EXPOSURE CONTROL CIRCUIT
DISTANCE CODE PLATE
72
67
18
17
AF MOTOR CONTROL CIRCUIT
CCD PROCESS CIRCUIT
AF CCD
21
AF PULSER
20
73
AF MOTOR
19
19a
22
BATTERY

FIG. 7

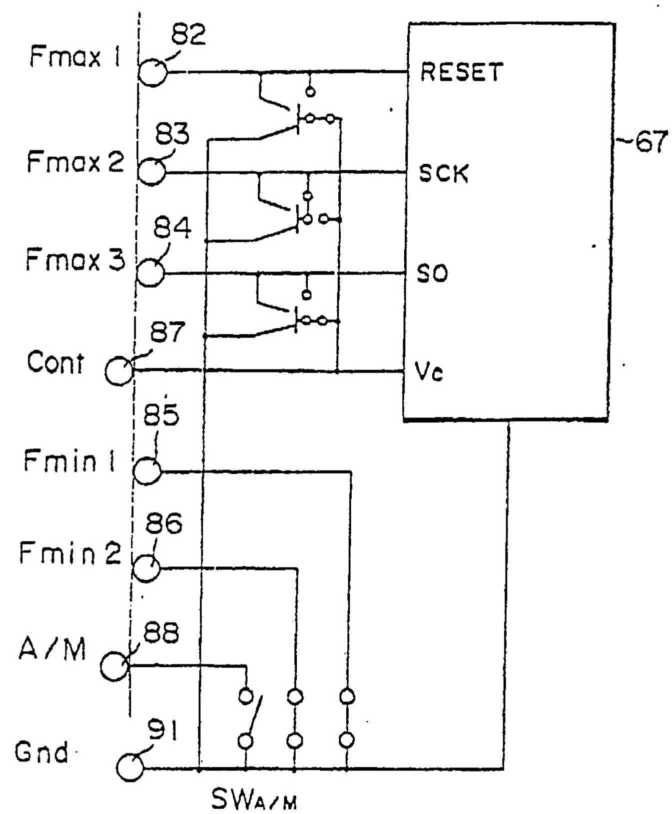

Fmax 1
82
RESET
83
67
Fmax 2
SCK
84
Fmax 3
SO
87
Cont
Vc
85
Fmin 1
86
Fmin 2
88
A/M
91
Gnd
SWA/M

FIG.8

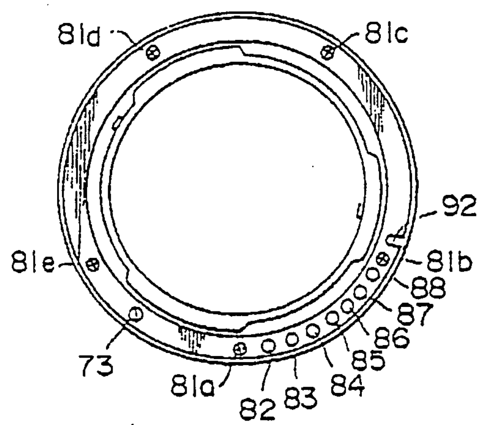

81d
81c
92
81e
81b
88
87
86
85
84
83
82
81a
73

FIG.9

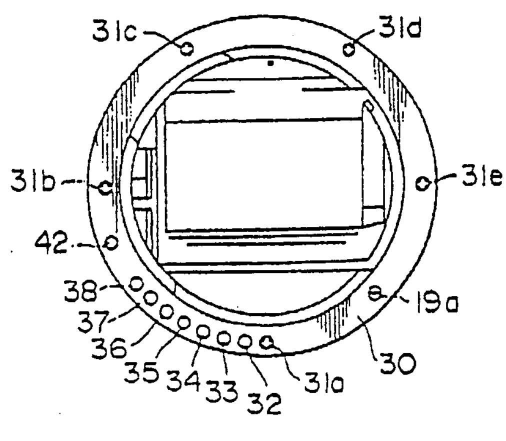

31c
31d
31b
31e
42
38
19a
37
36
35
34
33
32
31a
30

FIG. 10

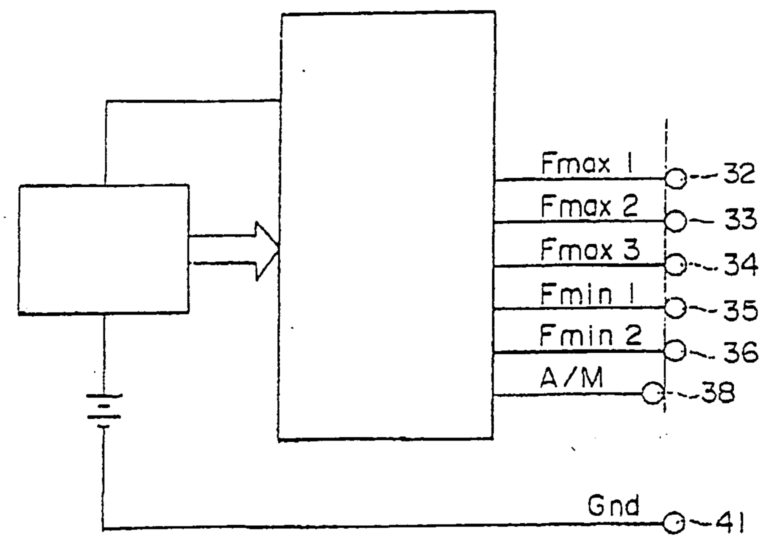

Fmax 1
Fmax 2
Fmax 3
Fmin 1
Fmin 2
A/M
32
33
34
35
36
38
Gnd
41

FIG. 11

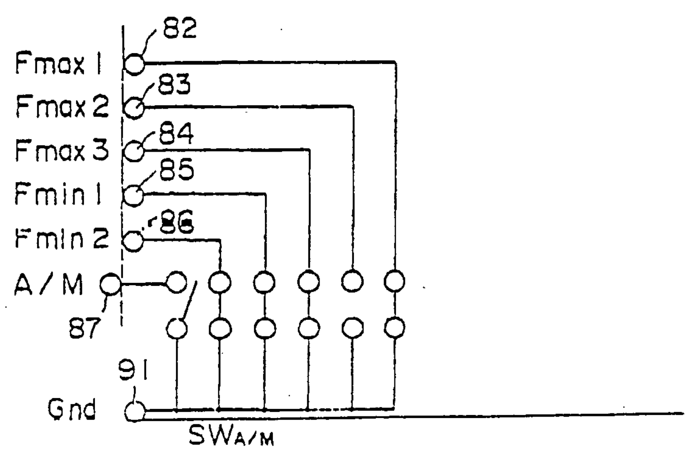
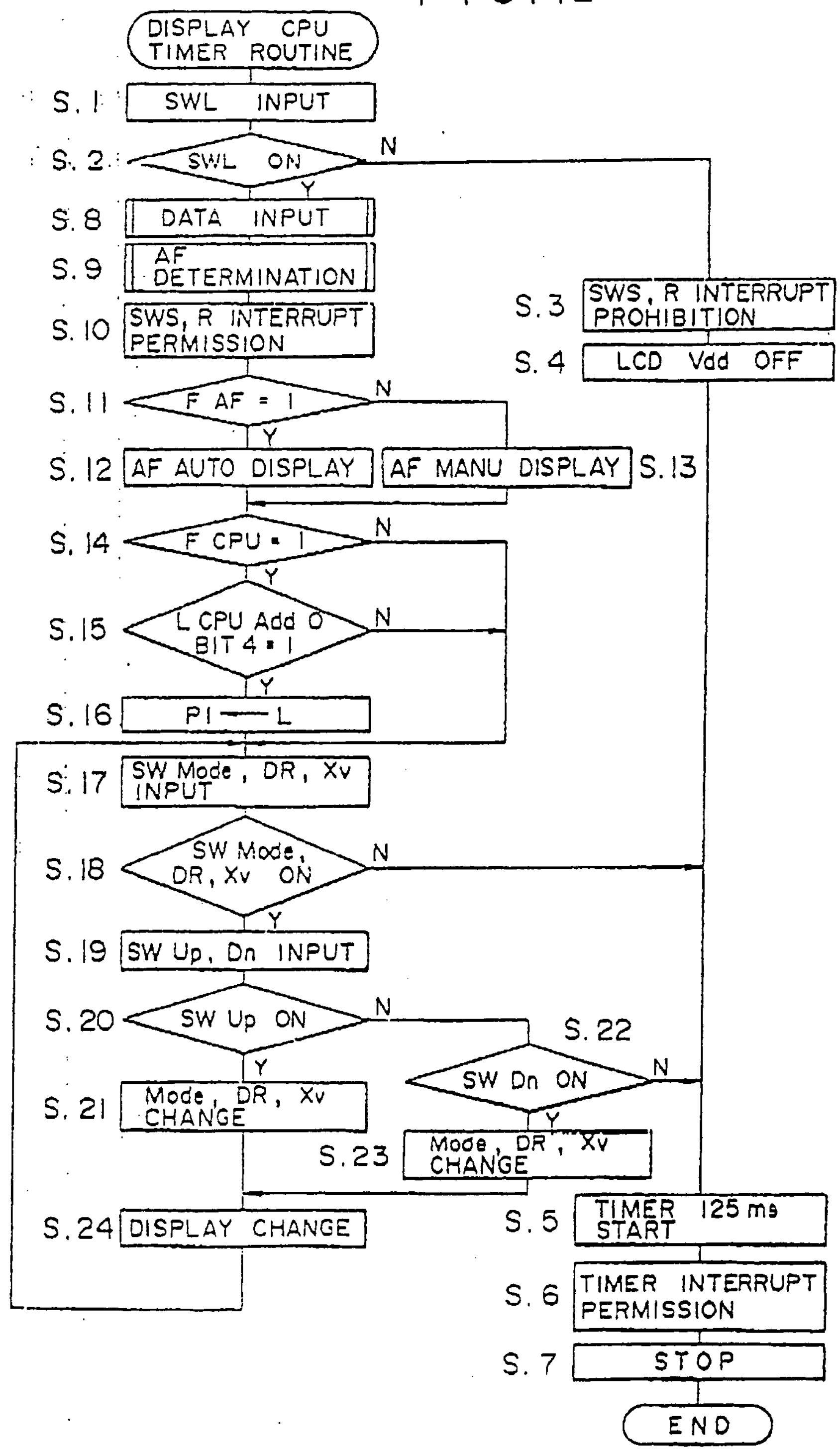

Fmax 1
Fmax 2
Fmax 3
Fmin 1
Fmin 2
A/M
82
83
84
85
86
87
91
Gnd
SWA/M

FIG. 12


DISPLAY CPU TIMER ROUTINE
S. 1
SWL INPUT
S. 2
SWL ON
N
Y
S. 8
DATA INPUT
S. 9
AF DETERMINATION
S. 10
SWS, R INTERRUPT PERMISSION
S. 3
SWS, R INTERRUPT PROHIBITION
S. 4
LCD Vdd OFF
S. 11
F AF = 1
S. 12
AF AUTO DISPLAY
AF MANU DISPLAY
S. 13
S. 14
F CPU = 1
S. 15
L CPU Add 0 BIT 4 = 1
S. 16
P1 — L
S. 17
SW Mode, DR, Xv INPUT
S. 18
SW Mode, DR, Xv ON
S. 19
SW Up, Dn INPUT
S. 20
SW Up ON
S. 22
SW Dn ON
S. 21
Mode, DR, Xv CHANGE
S. 23
Mode, DR, Xv CHANGE
S. 24
DISPLAY CHANGE
S. 5
TIMER 125 ms START
S. 6
TIMER INTERRUPT PERMISSION
S. 7
STOP
END

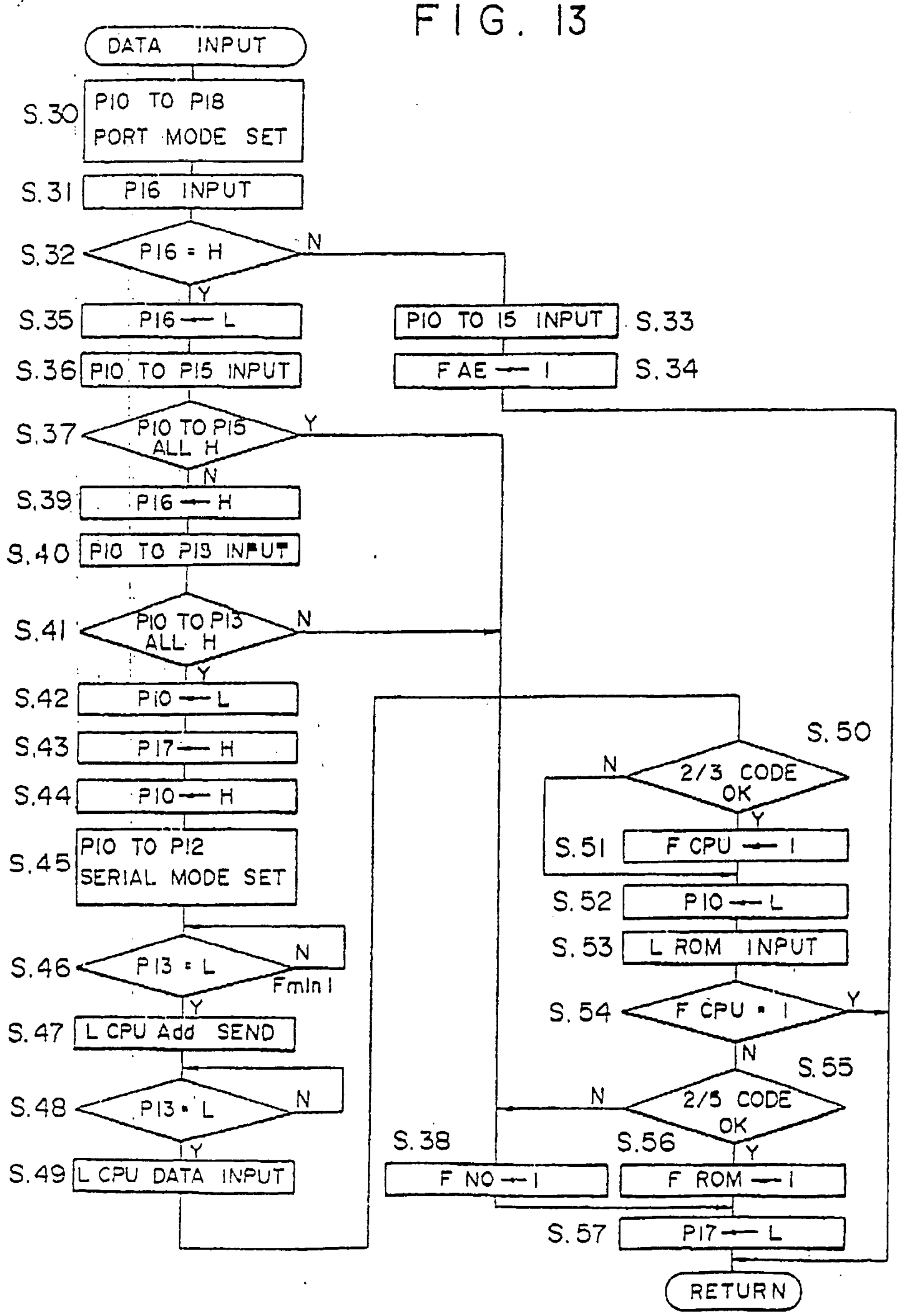

DATA INPUT
S.30
P10 TO P18 PORT MODE SET
S.31
P16 INPUT
S.32
P16 = H
N
Y
S.35
P16 ← L
S.36
P10 TO P15 INPUT
S.37
P10 TO P15 ALL H
Y
N
S.39
P16 ← H
S.40
P10 TO P13 INPUT
S.41
P10 TO P13 ALL H
N
Y
S.42
P10 ← L
S.43
P17 ← H
S.44
P10 ← H
S.45
P10 TO P12 SERIAL MODE SET
S.46
P13 = L
N
Fmln1
Y
S.47
L CPU Add SEND
S.48
P13 = L
N
Y
S.49
L CPU DATA INPUT
P10 TO 15 INPUT
S.33
F AE ← 1
S.34
S.50
2/3 CODE OK
N
Y
S.51
F CPU ← 1
S.52
P10 ← L
S.53
L ROM INPUT
S.54
F CPU = 1
Y
N
S.55
2/5 CODE OK
N
Y
S.38
F NO ← 1
S.56
F ROM ← 1
S.57
P17 ← L
RETURN

FIG. 13

FIG. 14 (a)

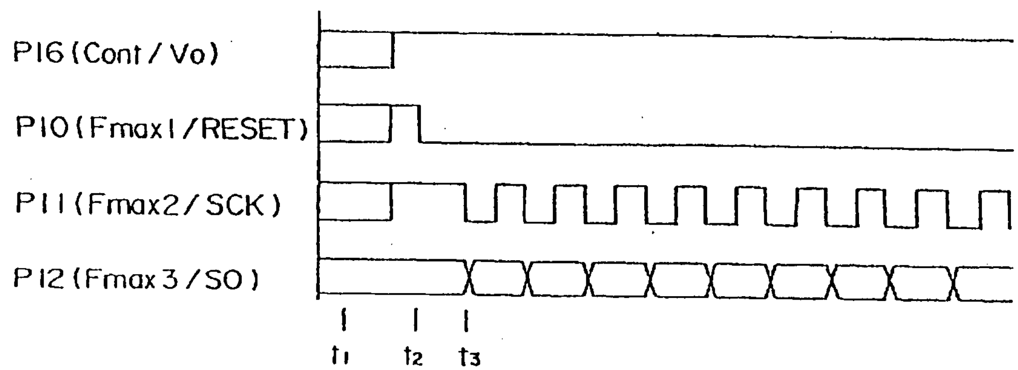


FIG. 14 (b)

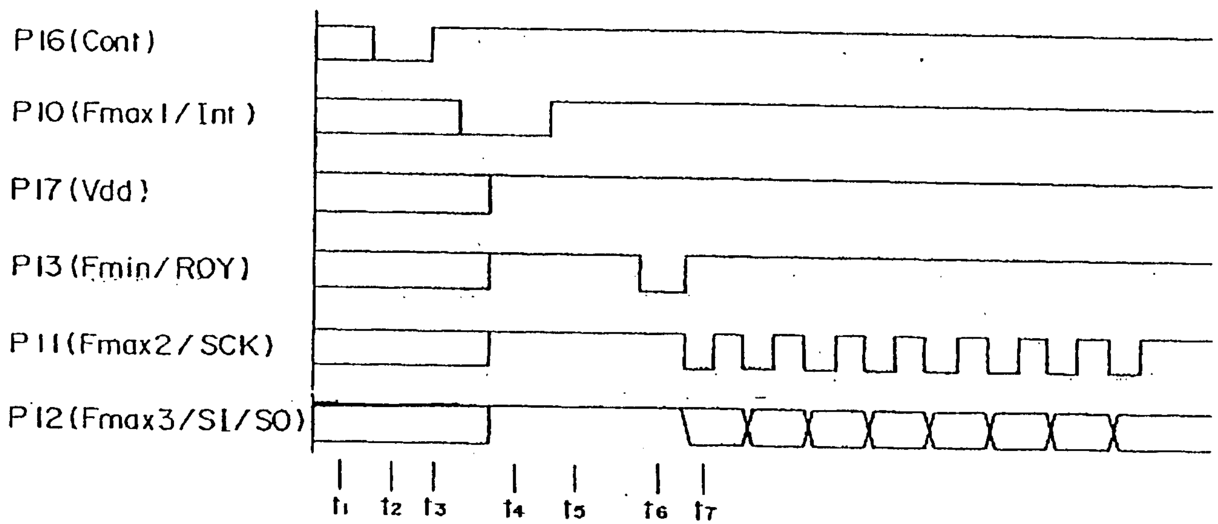


FIG. 15

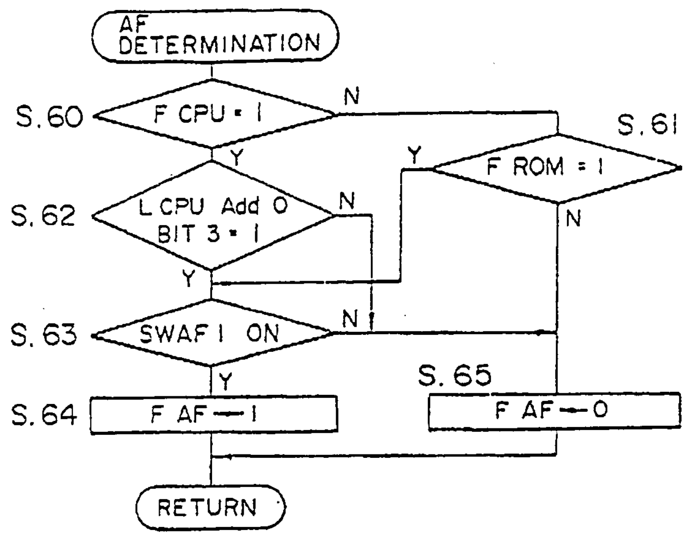


FIG. 16

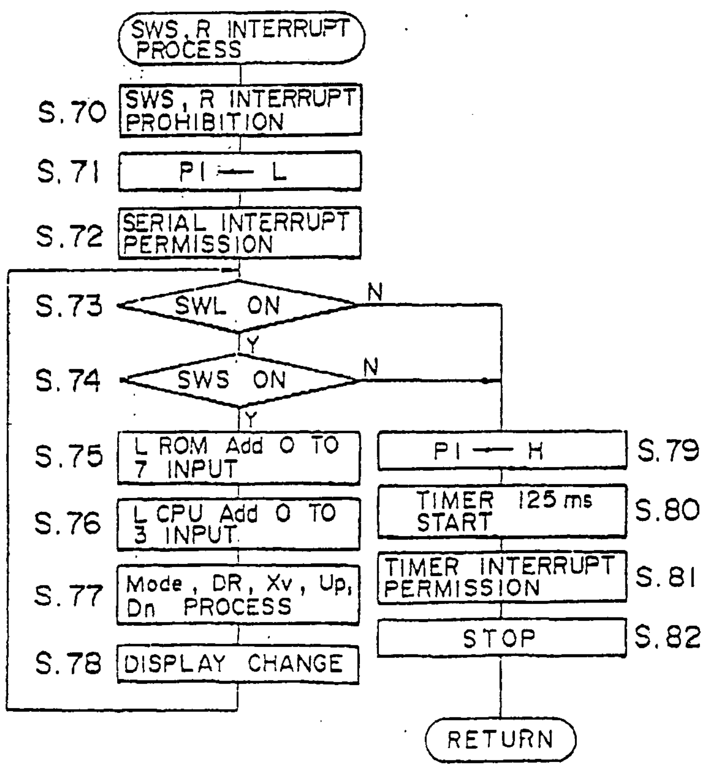


FIG. 17

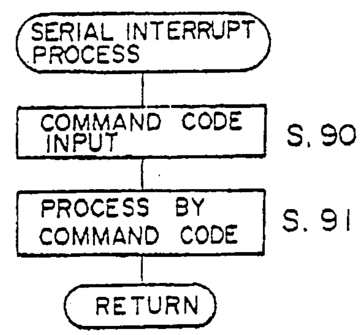


FIG. 18

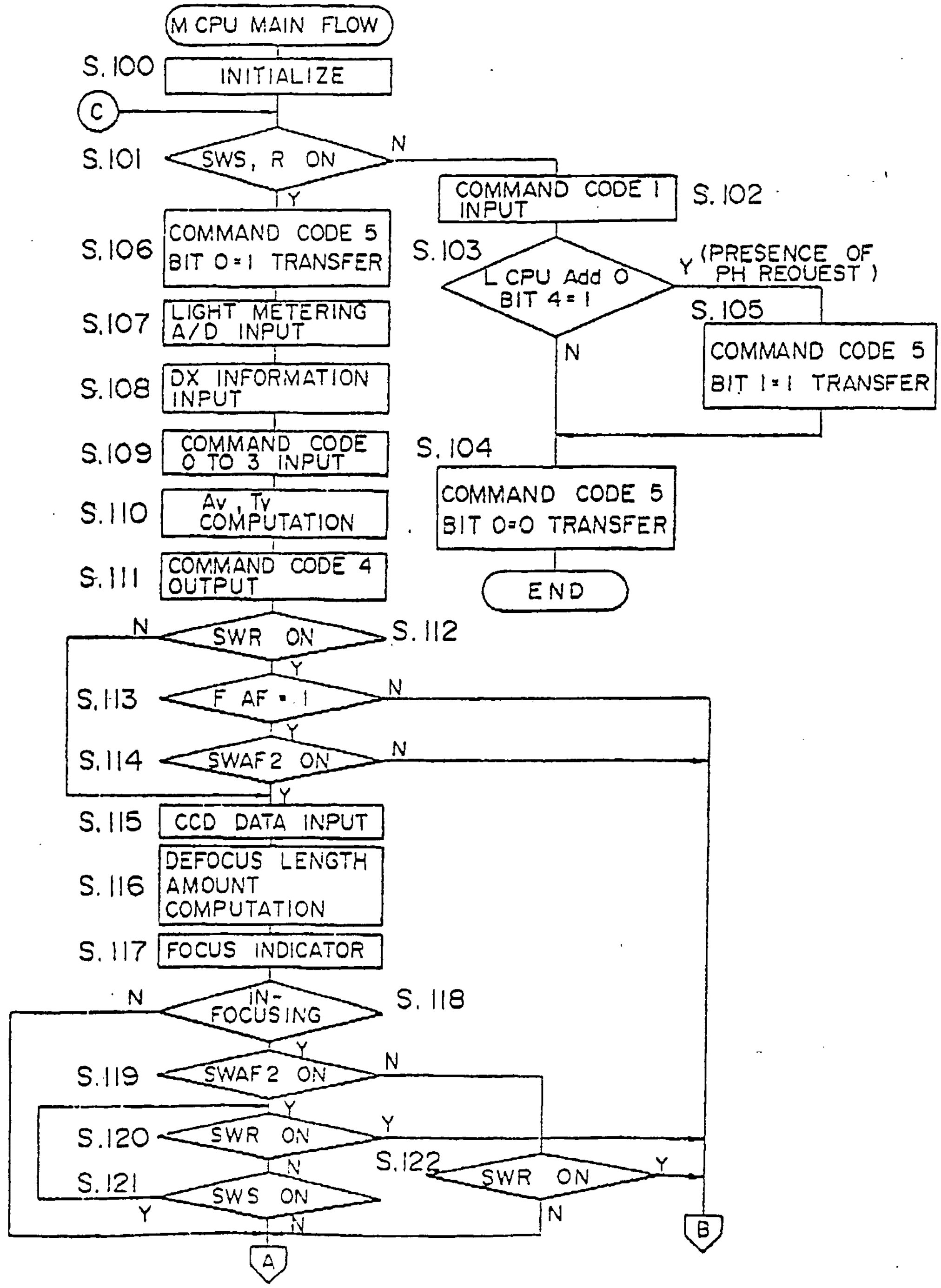

M CPU MAIN FLOW
S.100
INITIALIZE
C
S.101
SWS, R ON
N
Y
COMMAND CODE 1 INPUT
S.102
S.103
L CPU Add 0 BIT 4=1
Y
(PRESENCE OF PH REQUEST)
S.105
COMMAND CODE 5 BIT 1=1 TRANSFER
N
S.104
COMMAND CODE 5 BIT 0=0 TRANSFER
END
S.106
COMMAND CODE 5 BIT 0=1 TRANSFER
S.107
LIGHT METERING A/D INPUT
S.108
DX INFORMATION INPUT
S.109
COMMAND CODE 0 TO 3 INPUT
S.110
Av, Tv COMPUTATION
S.111
COMMAND CODE 4 OUTPUT
S.112
SWR ON
S.113
F AF = 1
S.114
SWAF2 ON
S.115
CCD DATA INPUT
S.116
DEFOCUS LENGTH AMOUNT COMPUTATION
S.117
FOCUS INDICATOR
S.118
IN-FOCUSING
S.119
SWAF2 ON
S.120
SWR ON
S.121
SWS ON
S.122
SWR ON
A
B

FIG.19

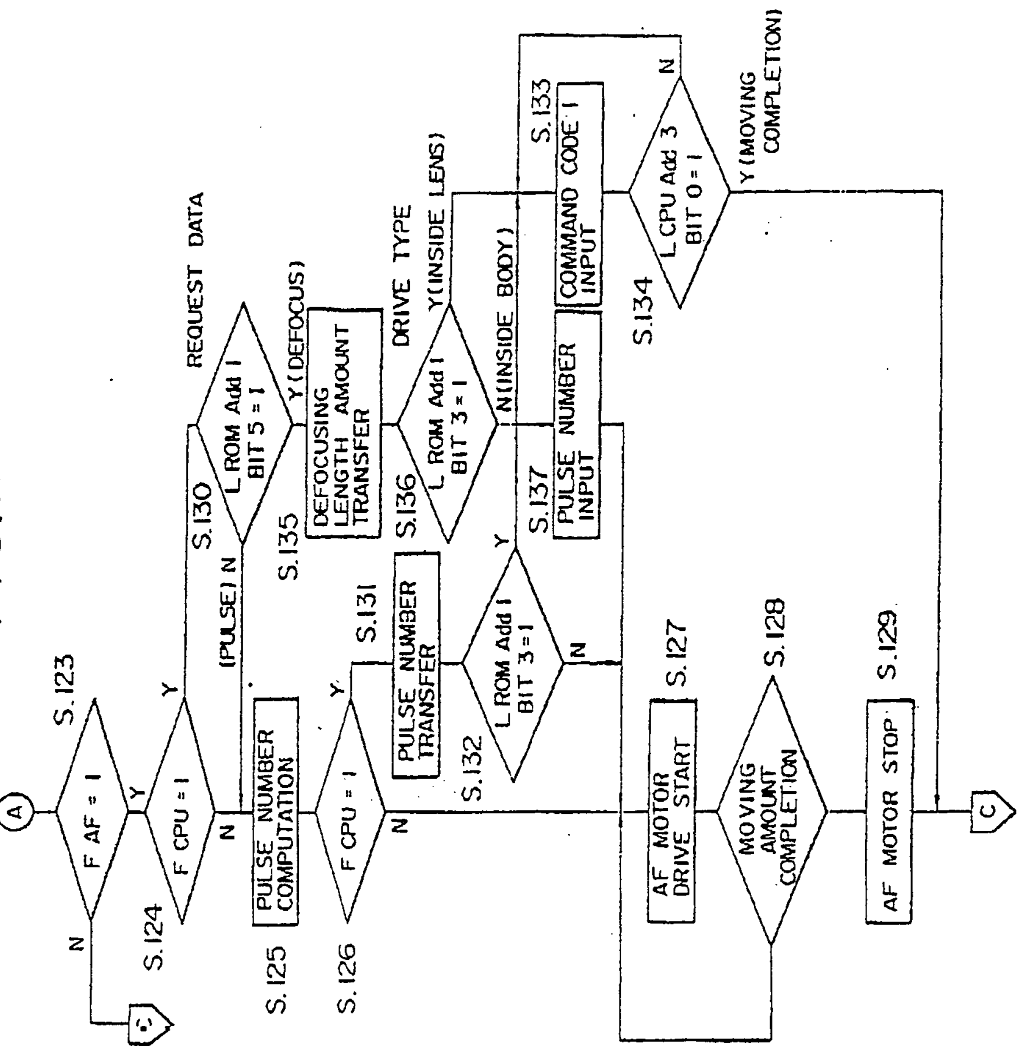

A
F AF = 1
S.123
N
Y
F CPU = 1
S.124
Y
N
PULSE NUMBER COMPUTATION
S.125
F CPU = 1
S.126
Y
N
S.130
L ROM Add 1 BIT 5 = 1
(PULSE) N
Y (DEFOCUS)
REQUEST DATA
S.135
DEFOCUSING LENGTH AMOUNT TRANSFER
S.136
L ROM Add 1 BIT 3 = 1
DRIVE TYPE
Y (INSIDE LENS)
N (INSIDE BODY)
S.131
PULSE NUMBER TRANSFER
S.132
L ROM Add 1 BIT 3 = 1
Y
N
S.137
PULSE NUMBER INPUT
S.133
COMMAND CODE 1 INPUT
S.134
L CPU Add 3 BIT 0 = 1
N
Y (MOVING COMPLETION)
AF MOTOR DRIVE START
S.127
MOVING AMOUNT COMPLETION
S.128
AF MOTOR STOP
S.129
C

FIG. 20

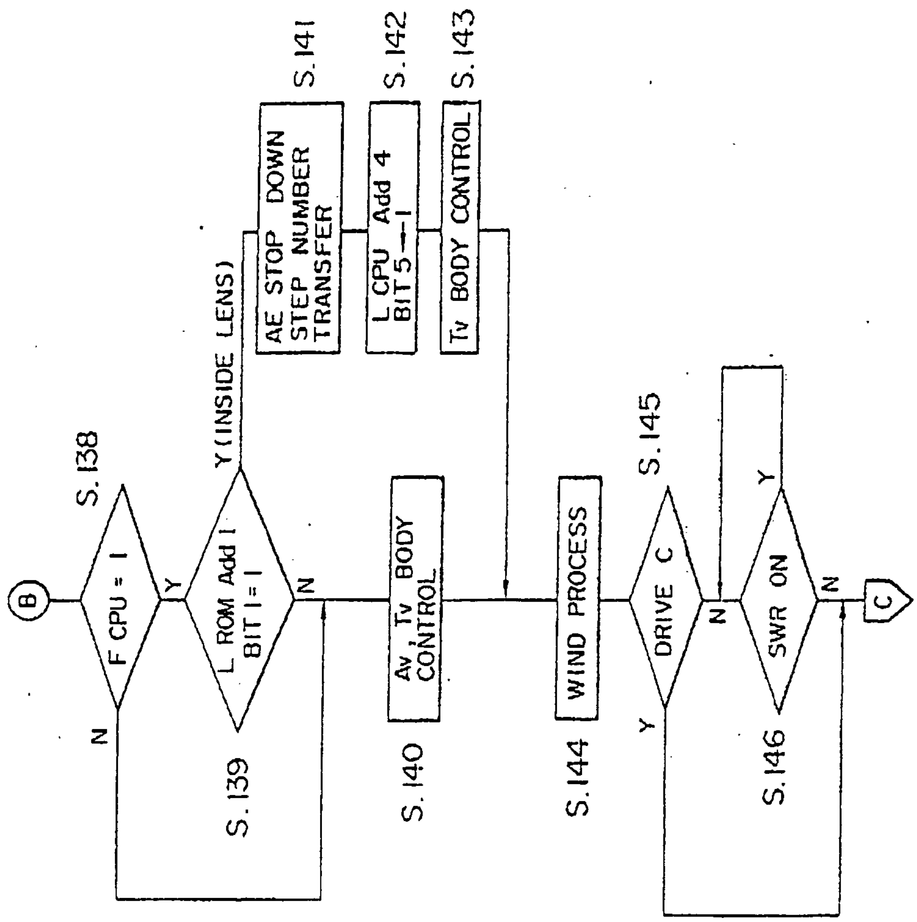

B
F CPU = 1
S.138
N
Y
L ROM Add 1
BIT 1 = 1
S.139
Y (INSIDE LENS)
N
AE STOP DOWN
STEP NUMBER
TRANSFER
S.141
L CPU Add 4
BIT 5 ← 1
S.142
Tv BODY CONTROL
S.143
Av, Tv BODY
CONTROL
S.140
WIND PROCESS
S.144
DRIVE C
S.145
Y
N
SWR ON
S.146
Y
N
C

FIG. 21

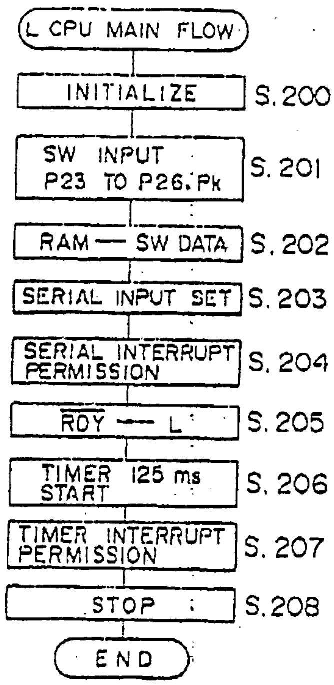
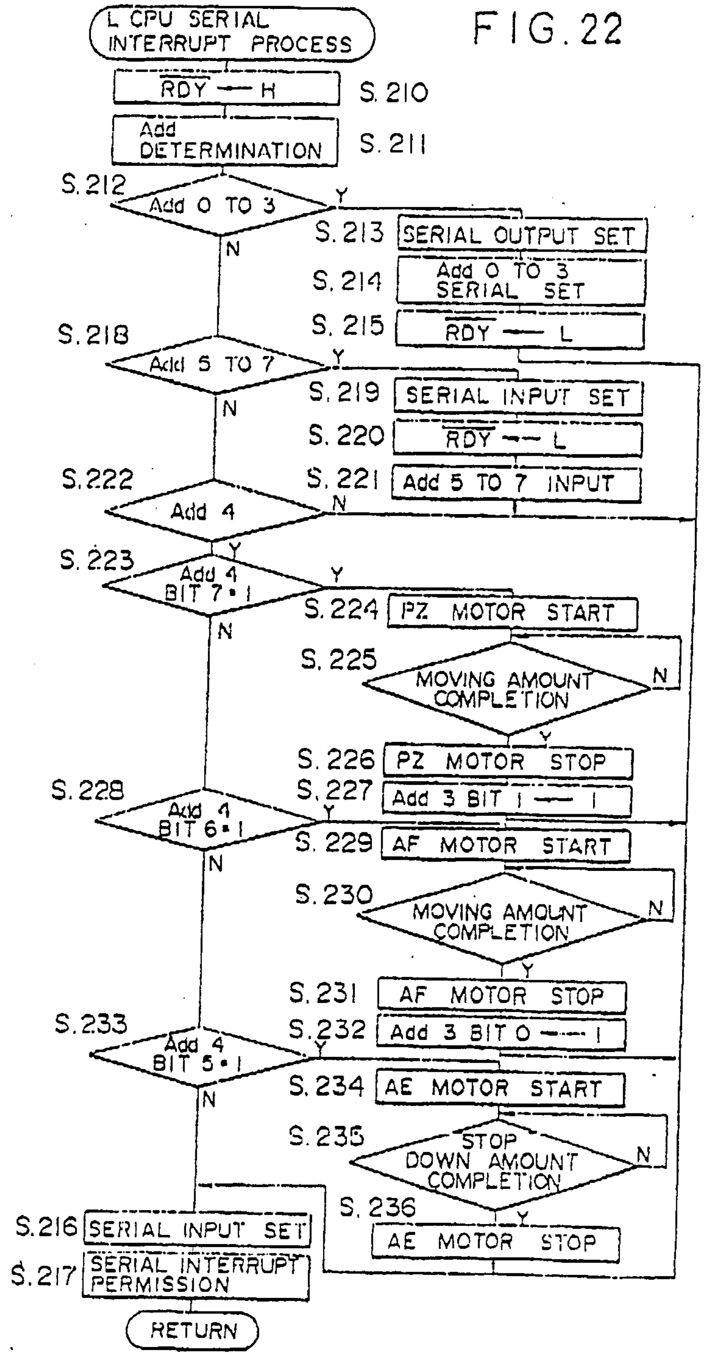

L CPU MAIN FLOW
INITIALIZE
S. 200
SW INPUT P23 TO P26. Pk
S. 201
RAM — SW DATA
S. 202
SERIAL INPUT SET
S. 203
SERIAL INTERRUPT PERMISSION
S. 204
RDY — L
S. 205
TIMER 125 ms START
S. 206
TIMER INTERRUPT PERMISSION
S. 207
STOP
S. 208
END

FIG. 22


L CPU SERIAL INTERRUPT PROCESS
RDY — H
S. 210
Add DETERMINATION
S. 211
S. 212
Add 0 TO 3
S. 213
SERIAL OUTPUT SET
S. 214
Add 0 TO 3 SERIAL SET
S. 215
RDY — L
S. 218
Add 5 TO 7
S. 219
SERIAL INPUT SET
S. 220
RDY — L
S. 221
Add 5 TO 7 INPUT
S. 222
Add 4
S. 223
Add 4 BIT 7 = 1
S. 224
PZ MOTOR START
S. 225
MOVING AMOUNT COMPLETION
S. 226
PZ MOTOR STOP
S. 227
Add 3 BIT 1 — 1
S. 228
Add 4 BIT 6 = 1
S. 229
AF MOTOR START
S. 230
MOVING AMOUNT COMPLETION
S. 231
AF MOTOR STOP
S. 232
Add 3 BIT 0 — 1
S. 233
Add 4 BIT 5 = 1
S. 234
AE MOTOR START
S. 235
STOP DOWN AMOUNT COMPLETION
S. 236
AE MOTOR STOP
S. 216
SERIAL INPUT SET
S. 217
SERIAL INTERRUPT PERMISSION
RETURN

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 89116967.4

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 5)
X	US - A - 4 336 987 (SHENK) * Fig. 1,5,6; claims *	1-8	G 03 B 3/10
X	GB - A - 2 039 681 (POLAROID) * Fig. 1,2; abstract; page 3, line 96 - page 4, line 7 *	6	
Y	* Fig. 1,2; abstract; claims *	1-5	
A	* Fig. 2; page 3, line 129 - page 4, line 18 *	7	
Y	GB - A - 2 139 368 (ASAHI) * Fig. 4-7; abstract; line 2 *	1-5,6	
Y	US - A - 4 236 794 (GORDON) * Fig. 3,5,6; column 8 *	1-6	
Y	US - A - 4 445 761 (ISHIKAWA) * Fig. 5,9; column 9, lines 24-28 *	1-6	

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

G 03 B 3/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	22-11-1989	KRAL

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document